TRANSACTIONS

OF THE

ROYAL SOCIETY OF SOUTH AFRICA

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OF THE

ROYAL SOCIETY OF SOUTH AFRICA.

Ordinary Monthly Meeting.

April 6, 1908.

Mr. S. S. Hough, F.R.S., President, in the Chair.

The President, in opening the proceedings, said that since they last met as the Philosophical Society the charter had been granted by the King, largely through the exertions of Dr. Péringuey, and on the present occasion they met for the first time as the Royal Society, duly constituted in South Africa. In accordance with the new statutes, the old Council had abandoned office, and had handed over its responsibilities to the new Council as drawn up by three members of the Royal Society of London resident in South Africa, and sanctioned by the former. This new Council had met and made arrangements to carry out the statutes. The formal opening of the new Society could not take place until the work of the Society was further advanced than it was at present. At the same time the Council had commenced its duties by electing officers on behalf of the Society. It had done him the honour of asking him to again occupy the presidential chair. The Council had also appointed Dr. L. Péringuey as Secretary, and the choice of Treasurer had fallen upon Dr. Bolus. He (the President) had been called upon to nominate two Vice-Presidents, and he had nominated Dr. Muir (Superintendent-General of Education) as the representative of the Cape Colony, and Dr. Theiler (of the Bacteriological Department, Pretoria) as the representative of the Transvaal. Both of these gentlemen had consented to occupy these positions.

The names of the following candidates for membership were announced as having been suspended: N. S. Pillans, Cape Town; S. Mendelssohn,

Kimberley; E. J. O'Connor, Cape Town; G. French, Cape Town; A. Lewis, Kimberley.

Professor Beattie read a paper on "Transvaal Sea-level Temperatures," by Mr. R. T. A. Innes, formerly of the Cape Observatory. The object of the paper was to find what reductions applied to temperature readings in the Transvaal would reduce them to sea-level temperatures. For this purpose a curve was plotted with the temperature entered horizontally and the altitudes vertically. This was assumed to be a parabola, and the correction was calculated on this assumption. A comparison with Buchan's maps in Bartholomew's Meteorological Atlas showed great differences. These the writer attributed to the fact that Buchan had no South African data on which to base his correction.

"Introductory Note on the Geology and Mineralogy of Albany."* Professor Young described the evidence he had of volcanic action having occurred in the Albany district along a line of crystal weakness running east and west some miles to the south of Grahamstown.

He described some investigations he had carried out on some of the rocks and minerals found in the neighbourhood of this volcanic line.

The evidence goes to show that the district is mineralised with gold and other rare metals, and that a mineral grease or oil occurs in association with the rare metals.

He also suggested several chemical reasons to account for the failure of most South African assayers to detect these metals, while the European assayers have found them in several hundreds of samples from Albany during the last two years.

Dr. Rogers remarked that no evidence of contemporaneous volcanic activity during Witteberg times that would stand criticism had been presented. Professor Young had kindly given him for examination two thin rock slices containing some of the evidence, but the speaker could not recognise it as valid. Objects which the author regarded as vesicular lapilli the speaker took to be sections through plant fragments, crushed in places but still clearly of vegetable origin; he instanced the shape of the cells as seen in transverse and longitudinal sections, the thinness of the cell-walls where the fragments were least crushed, and the absence of microlites, &c., from them. The non-vesicular fragments the speaker regarded as possibly volcanic tuffs with quartz grains, and he pointed out possible sources of such rocks from pre-Cape beds in the north, beds which had furnished much volcanic material to the succeeding Dwyka Series through various agencies of denudation and transport. The speaker could not recognise palagonite in the slices. As the author had connected the Rooi Kop rocks with the Zuurberg fissure, and regarded

* The paper was eventually withdrawn.

that site as a source of lapilli during Witteberg times, he would have to prove the contemporaneity of the vulcanism and its continuance through Karroo times, for the Zuurberg fissure was certainly of post-Dwyka date, probably post-Uitenhage. The crumpling of the Witteberg strata near Rooi Kop could hardly be attributed to contemporaneous volcanic activity; such crumpling, also, is unknown from the neighbourhood of the Drakensberg and later volcanoes in Cape Colony. The speaker deprecated the revival of a volcanic theory of the Dwyka Series without good evidence.

Dr. C. F. Juritz thought it probable that some of the curious reactions described in connection with the processes whereby platinum was said to have been extracted from the rocks of the Albany district, and attributed to the presence of metals hitherto unknown to science, would eventually be found to have very simple explanations. For instance, a greenish-black precipitate, which turned greyish-white, most likely resulted from nothing more than iron, the change of colour being due to the gradual deposition of free sulphur. A white precipitate, also put down to some new metal, was apparently only silver chloride derived from the silver dish prescribed in the process for the preliminary fusion of the rock, and the fact that this silver chloride would not dissolve in the usual solvents of that substance seemed to be due entirely to its having been exposed to light. Another hypothetical metal had been associated with the pink colour said to be developed at some stages of the process; now he had heard that under certain conditions also a green colour was produced, and it looked as though these were caused simply by manganese. The mineral Bushmanite (Dana's "System," 6th ed., p. 955)—a manganese alum—occurred abundantly along the banks of, and, in fact, derived its name from, Bushman's River, which flowed through the very area supposed to be platiniferous. He considered it unfortunate that, where the stupendous assay results of hundreds of ounces of platinum per ton of rock had been reported, there had always seemed to be a link missing in the chain of evidence connecting the assay with the site; and, on the other hand, where the chain was complete the proportions of platinum found were quite infinitesimal. Much had therefore to be taken on trust, and to constitute an acknowledged scientific fact more than this was needed. The attitude of chemists was consequently not one of enthusiasm regarding the future of the reported discoveries; they were still waiting to be convinced.

Dr. G. Corstorphine pointed out that the angularity of the quartz splinters in a rock was no evidence of its volcanic origin; such sharp fragments were of common occurrence in rocks which contain small fragments. It is a usual experience to find the larger grains sub-angular or rounded and the smaller angular in ordinary sedimentary rocks. He

remarked the general resemblance of the rock from which thin slices had been cut to much of the Dwyka. He sketched the history of our knowledge of the Dwyka Series, and noted that the existence of volcanic rocks south of the Zuurberg, along the line of strike of the Dwyka there, very probably gave rise to or at least strengthened the volcanic theory of the Dwyka in the minds of the pioneer geologists, as had been pointed out in a survey publication. Modern petrologists had given up the volcanic theory after personal experience of the rock both in the field and the laboratory, though, on the evidence of hand specimens and thin sections alone, some of them had at first favoured the theory. He could not recognise evidence of contemporaneous volcanic activity in the facts laid before the Society, nor could he recognise lapilli in the cellular structures, which he thought were of vegetable origin. He then gave an account of the persistent but fruitless endeavours on the part of the Consolidated Goldfields Company to obtain evidence of payable platinum in the district.

Professor Young, in the course of a brief reply, said that his reference to the Dwyka Series being possibly in part of volcanic origin had been thrown out simply as a suggestion. It was impossible to believe that all the hundreds of samples sent by the Grahamstown people had been salted. Personally he believed that the only question on which some reasonable doubt might still be entertained was the economic one as to whether it would pay to extract the platinum. In answer to a question asked by Dr. Marloth, Professor Young said he had as yet seen no reason to believe that there was any native metallic platinum. He had not seen the slightest speck of metallic platinum in the district, and the platinum must occur there in some new minerals hitherto unknown to science.

Ordinary Monthly Meeting.

June 17, 1908.

Mr. S. S. Hough, F.R.S., President, in the Chair.

Messrs. N. S. Pillans, S. Mendelssohn, E. J. O'Connor, G. French, and A. Lewis were elected members of the Society.

Dr. Marloth exhibited a plant, probably a species of Bulbine, which possesses a tuber and a few very succulent leaves. The remarkable feature of these leaves is that they are embedded in the soil, and show only the somewhat convex apex. This apex is quite colourless and acts as a receiver for the light, which passes through the clear, transparent tissue and reaches the green tissue, which forms a thin layer only, from the inner side. The lower portion of the leaf is darker green than the upper one, although buried deeper in the soil. This is due to the fact

that the epidermal lens at the apex naturally sends more light towards the base than towards the upper parts. There is no other plant known that has such leaves, but Dr. Marloth cannot describe the species until the specimens he is cultivating have produced flowers.

Dr. L. PÉRINGUEY, the General Secretary, read a description of a new Transvaal tick, a variety of *Ixodes pilosus*, Koch, by Mr. J. G. Neumann, Professor at the Veterinary School, Toulouse, France.

Mr. C. W. HOWARD, the Entomologist of the Transvaal Agricultural Department, sent a note on the distribution and hosts of the new Transvaal tick *Ixodes pilosus howardi*, Neum., the first specimens of which were sent to him by Dr. Copland, District Surgeon at Leydsdorp, and about the same time Dr. Theiler brought specimens from Durban. Mr. Lounsbury, in one of his reports, stated that *I. pilosus* was only found in the Cape Colony in places which were very humid, such as kloofs containing a stream of running water or in the vicinity of vleis. Apparently *I. pilosus howardi* was not limited in its distribution to these conditions, since Mr. Howard had taken specimens from places which were more or less dry unless they could consider Durban as humid, but such places as Leydsdorp and Zoutpansberg, from which some of the specimens were taken were very arid. The principal host was the dog, but at the Ivy Mine, Moodies, Barberton, a few specimens were found on a cat, and a few on a hedgehog at Pienaars River.

Mr. W. T. SAXTON contributed a note on the occurrence of the Genus *Sphæroplea* in South Africa.

The previously noted localities where the green *Alga Sphæroplea* occurs are the inundated plains of Central Europe, Asia, and America.

Specimens were collected in South Africa by Mr. Saxton in a freshwater pool on Dassen Island nearly two years ago, and again recently in pools on Green Point Common by Mr. E. P. Phillips. The *Alga* is interesting as representing a monotypic and rather isolated family, and is the only one of its species known. Diagrams were shown illustrating the structure and life-history.

Dr. C. F. JURITZ read a communication on "Some Investigations regarding 'Brak' (Alkali) in Cape Colony Soils."

Brak, or alkali, in soil consisted of accumulations of sodium salts. Rainy weather carried them to varying depths, but prolonged dry weather caused their return to the surface. Irrigation tended to accentuate these conditions, hence the adaptability of any tract of country for irrigation depended, other things apart, upon the proportion in the soil of salts which might render it unproductive. To test a soil as to its liability to become brak under irrigation it was essential to take samples at regular intervals all the way down from the surface to the greatest depth which irrigation water might penetrate. Brak was caused by carbonate, chloride,

and sulphate of sodium, the first doing the most and the last the least injury. Natural drainage usually carried these noxious salts seawards, but this was prevented by (1) an impermeable layer below the surface forming a basin; (2) compactness of the soil itself; and (3) a high water-line in the subsoil. Even these obstacles, where frequent rain resulted in an even distribution of salts throughout the soil, were not always sufficient to prevent successful cultivation. The difficulty arose with a scanty rainfall and a warm climate, or long drought after heavy rain; then it became important to ascertain how much salt the soil could contain and still be successfully cultivated.

Investigations had been made in the divisions of Herbert, Colesberg, Britstown, Steynsburg, Robertson, and Carnarvon. In the first two cases only the soils at the surface were examined. The Britstown soils increased steadily in brak from the surface down to 6 feet; the low rainfall did not permit of moisture penetrating to any depth and bringing up salts from below, but irrigation might alter this. Sodium carbonate was, however, practically absent. At Steynsburg a series of excavations, made over an area extending across 2 miles, showed large quantities of brak in the subsoil. The conditions grew worse as one proceeded down the valley, and only one of the soils fell within safe limits. The most abundant salt was sodium chloride, then came sodium sulphate, and in some cases sodium carbonate (black brak) was present, the soluble salts being distributed very irregularly through the soil. The effect of irrigation and cultivation was shown in connection with a soil from a brak patch on the Government Experiment Station at Robertson. Here analysis showed the greatest amount of salt at the surface, and a considerable diminution downwards. Near Van Wijk's Vlei both types of curve were illustrated. One soil, continuously cultivated for seventeen years, showed over $2\frac{1}{2}$ per cent. of soluble salts at the surface, diminishing to less than one-fourth that amount at a depth of 6 feet. A virgin soil from the same place showed only 0·2 per cent. at the surface, but on penetrating the soil this amount increased fivefold at the first foot. The former of the two soils had ceased to be capable of bearing crops—a fact explained by the existence of large quantities of sodium and calcium chlorides in the surface soil.

Ordinary Monthly Meeting.

July 15, 1908.

Mr. S. S. Hough, President, in the Chair.

Messrs. E. P. Phillips, A. H. Kirkman, E. L. Calverley, J. G. Rose, and H. Lotz were elected members of the Society.

Mr. J. H. Henkel, of the Forest Department, exhibited some tufts of a grass, *Ehrharta villosa*, Sch., growing on the sand-dunes, and aborted in a very singular manner through the agency of a species of Cecydomid fly not yet identified. The malformed part forms, however, such a thick covering that the insect, which is of a most delicate build, could not escape when reaching maturity were it not that the plant itself forced the partially aborted shoot tenanted by the larvæ out of the malformed sheet and the midge is thus enabled to pupate and emerge in the open.

An abstract of a "Preliminary Note on the Diurnal Variation of Level at Kimberley," by Dr. J. R. Sutton, was read. This paper gives the preliminary results of observations made during the course of three years upon the variation of the level of the ground as recorded by a large horizontal pendulum of a special design made for the author by the Cambridge Instrument Company. It appears from the results that the movements in the surface of the ground which set up corresponding movements on the pendulum at Kimberley are very great. The maximum westerly elongation of the extremity of the pendulum occurs about 5.30 a.m.; the maximum easterly about 4.15 p.m.; the median positions a little before 11 a.m. and 9.30 p.m. Geometrically these movements may be represented on the hypothesis that the hemisphere facing the sun bulges out, forming a sort of meniscus to the geosphere. The enormous rise and fall of the surface of the land that such a supposition would postulate are, however, mechanically difficult. It is curious that the range of the pendulum's excursion from west to east during the day is twice as great in winter as it is in summer. The author concludes from this that since the soil of Kimberley is usually very dry during the winter, the movements of water enclosed in the soil cannot be held responsible for the behaviour of the pendulum—as has sometimes been suggested. Not so much connection as might have been expected can be traced between the variations of weather and the movements of the pendulum. Barometric pressure variations and cloud are perhaps the most potent disturbers of the regular movements of the pendulum. In the years under discussion there was a strong tendency for the pendulum to deviate to the west of its mean position during the winter and to the east during the summer. This, if confirmed by subsequent observation, would indicate a response to the loading of the continent by rain on the east coast in summer and the west coast in winter, and to the unloading by evaporation in the opposite seasons. This point should be further investigated.

ORDINARY MONTHLY MEETING.

August 19, 1908.

Mr. S. S. HOUGH, F.R.S., President, in the Chair.

Mr. J. D. GRIMMER was elected an ordinary member of the Society.

The PRESIDENT announced that one of the original Council members, Mr. Denny, had tendered his resignation owing to his leaving South Africa, and the Council had nominated in his stead Mr. INNES, of the Government Meteorological Station, Johannesburg. This nomination, he stated, would be submitted for confirmation at a future meeting.

The President further announced that the Council had to nominate certain gentlemen for election as Honorary Fellows. So far they had only selected one gentleman, whose name would be submitted to the next meeting. He referred to Sir DAVID GILL, whose nomination, he was sure, would be received with general approbation.

Dr. MARLOTH exhibited for the information of the Society a specimen of a young plant reared from seed spread by ocean currents, as showing the fertility of such seeds, although carried a long distance on ocean currents. The plant exhibited was *Cæsalpinia bonducella*, a native of South America. It had been raised from a seed that had been picked up on the beach at Tristan da Cunha by Mr. Keytel, who visited the island in 1907, and is at present spending a year on the island. Another seed, from a climbing leguminous plant, viz., *Pusætha* (*Entada*) *scandens*, had also been found by him, but this had not germinated as yet, and may be dead. These seeds were brought to the island by the currents of the ocean, and the people at Tristan and St. Helena, who fished them up or picked them up on the beach, called them seabeans, thinking that they had grown somewhere in the sea. It was generally assumed that these seeds had lost their vitality when they reached distant shores, but, as this plant showed, such was not always the case. Dr. Marloth had placed the seed in the warm house of the Municipal Gardens, where it germinated within two months after being planted; hence there was no doubt that these plants might be spread from one continent to another by the currents of the sea, provided, of course, that they reach a locality which suits them.

Mr. A. L. DU TOIT exhibited specimens of granulites and ultrabasic rocks occurring as inclusions in Kimberlite (blue ground) in various pipes in northern Cape Colony. The interest attached to these rocks, he said, was very great on account of the information which they furnish regarding the nature of the comparatively unknown inner portion of the earth's crust. These fragments had been brought to the surface from immense depths, and their detailed study and investigation should throw a vast

amount of light upon their origin, as well as upon the processes of rock metamorphism in the earth's interior. Nearly all the specimens shown were peculiar to South Africa.

Dr. J. K. L. HALM spoke on the application of Doppler's principle to astro-physical problems. The lecturer dwelt on the importance of this principle in determining the motions of the celestial bodies in the line of sight by means of the displacements of the lines of their spectra from their normal positions, and illustrated its application by such examples as binary stars, Saturn's rings, the rotation of the sun, and the motion of the earth in its orbit round the sun.

ORDINARY MONTHLY MEETING.

September 16, 1908.

Mr. S. S. HOUGH, F.R.S., President, in the Chair.

Dr. MARLOTH read a note on the pollination of *Belmontia cordata*.

Belmontia cordata is a small annual, with a bunch of bright yellow, star-shaped flowers, fairly numerous just now around Cape Town and in the Flats. The flowers possess several remarkable contrivances, and although the plant is so common, it had not been possible, up to the present, to understand their function, and to find any insect which could have carried the pollen from one flower to another. The flowers are scented, and possess small appendages at their anthers, called Brown's bodies. They contain a sugary fluid, and this, it has been ascertained now, attracts a tiny, small insect, hardly one-fifteenth of an inch long, belonging to the *Thrips* family. The flowers possess two kinds of stigmas for the reception of the pollen, a structure which is not known from any other plant. This secondary stigma secures pollination in case the terminal stigma should not have received some pollen in time.

Miss E. L. STEVENS read a paper on the "Embryo-Sac of the Penæaceæ," a small order confined to the south-west region of Cape Colony. The embryo-sac of this order, she said, differs from that of the typical Angiosperm in containing sixteen nuclei instead of eight (these sixteen nuclei being organised into four egg-apparatus), and a definitive nucleus formed by the fusion of four of the nuclei. The early stages in the development of the sac show none of the polarity considered to be so characteristic of the Angiosperm sac; and the whole structure of the sac is confirmatory of Dr. Pearson's hypothesis regarding the origin of the Endosperm of Angiosperms.

Professor H. H. W. PEARSON read a note on "Endosperm." He said: "Of the many characteristics which distinguish the living Gymnosperms

from the Angiosperms, perhaps none is of greater importance than the origin of the Endosperm. In the former group the Endosperm is a prothallus homologous with that of the ferns. In the Angiosperms, on the contrary, the Endosperm is derived from a fusion-nucleus—the primary Endosperm nucleus. In *Welwitschia*, probably the highest living Gymnosperm, the Endosperm arises from the fusion of a large number of potentially sexual nuclei. This method of Endosperm formation appears to be characteristic also of the allied genus *Gnetum*, and to occur in no other Gymnosperm. It is suggested that the Endosperm of the Angiosperm is derived by a series of reductions and degrees of specialisation from a primitive type, essentially similar to that now found in *Welwitschia*. This hypothesis is strengthened by the fact that stages in this process can be identified in living Angiosperms. If these views are sustained, there is established an important link between the Gymnosperms and the Angiosperms, groups whose inter-relationships are obscure.

The PRESIDENT announced the election of Sir DAVID GILL as Honorary Fellow of the Society.

Mr. A. F. WILLIAMS, of Kimberley, was elected Ordinary member.

ORDINARY MONTHLY MEETING.

October 21, 1908.

Mr. S. S. HOUGH, F.R.S., President, in the Chair.

The PRESIDENT read the list of the newly elected Fellows of the Royal Society of South Africa: A. J. ANDERSON, M.A., M.B., &c., Cape Town; H. C. BEHR, M.I.C.E., Johannesburg; H. BOHLE, M.I.C.E., Cape Town; W. A. CALDECOTT, B.A., Johannesburg; L. CRAWFORD, M.A., D.Sc., Cape Town; J. BURTT-DAVY, F.L.S., Pretoria; P. D. HAHN, Ph.D., Cape Town; J. K. E. HALM, Ph.D., Cape Town; H. C. SCHUNKE HOLLWAY, F.R.S.E., Paarl; H. INGLE, B.A., F.C.S., Pretoria; R. T. A. INNES, F.R.M.S., Johannesburg; H. KYNASTON, B.A., Pretoria; R. A. LEHFELDT, D.Sc., Johannesburg; C. P. LOUNSBURY, B.A., Cape Town; R. MARLOTH, Ph.D., Cape Town; J. MOIR, D.Sc., Johannesburg; J. T. MORRISON, M.A., B.Sc., Stellenbosch; E. NEVILLE, F.R.S., Durban; A. OGG, M.A., Ph.D., Grahamstown; H. H. W. PEARSON, M.A., Sc.D., Cape Town; W. F. PURCELL, B.A., Ph.D., Cape Town; A. W. ROBERTS, D.Sc., Lovedale; W. ROBERTSON, M.R.C.S., Cape Town; A. W. ROGERS, M.A., D.Sc., Cape Town; S. SCHONLAND, Ph.D., M.A., Grahamstown; E. H. L. SCHWARZ, A.R.C.S., Grahamstown; J. R. SUTTON, D.Sc., M.A., Kimberley; E. WARREN, D.Sc., Pietermaritzburg; and F. J. WAY, M.I.C.E., Johannesburg.

Dr. Péringuey exhibited some *fac-simile* of Bushman paintings published in colour in 1838, and probably taken in 1830. These paintings were traced anew in 1872, and were copied again last year. The colour of the originals had not faded in the least. The great resistance of the pigment to the sundry destructive agencies, as evinced in the present case, was a point of great importance, as it justified the antiquarian in assigning to these reproductions a greater age than would be anticipated from the fragility of these paintings. We know also of the wonderful preservation of similar frescoes in the lately discovered caves of Almadira in Portugal, or in the Landes and Dordogne in France. Although these Bushman pictures were in all likelihood of a much more recent period, it was impossible at present to assign them a date. He could only say that all, or nearly all those he knew of, found in the western part of South Africa represented only the *feræ naturæ* of the country; whereas many of those occurring in the eastern part of Cape Colony contained representations of domesticated animals—horse, cattle, dog. He doubted if many of these were the work of the same race that painted in the west.

He exhibited also bones of large animals, such as the ox, possibly the eland, &c., found in a cavern lately discovered, the fractured parts of which might have been caused by the gnawing of wild beasts; two large horn cores, however, probably used as clubs, and a calcined bone, of which the marrow had been extracted, testified to man's agency.

Dr. A. W. Rogers read a "Note on the Structure of Tygerberg, Prince Albert." He observed that in 1906 Dr. Sandberg had published a paper throwing doubt on the anticlinical structure of Tygerberg as described by Mr. A. R. Sawyer and Professor E. H. L. Schwarz. The two latter geologists found the range to be the top of a sharp fold of Witteberg beds projecting along the middle of an anticline in the Dwyka and Ecca Series. Dr. Sandberg came to the conclusion that Tygerberg was the northern extremity of a fold which had its root in the foothills of the Zwartbergen, and which had been bent northward over younger beds (Lower Karoo), so that the crest of the fold was now a trough separated from the main mass of the Witteberg beds by denudation. He laid stress on the occurrence of masses of quartzite supposed to be pieces of the Witteberg Series disconnected by denudation from the Tygerberg mass, in the Dwyka area; and also on the supposed occurrence of Witteberg beds in an inverted position in the valley of the Sand River, where the remains of the former connecting link between Tygerberg and the foothills should be found. Dr. Sandberg had recently restated his views in the *Geological Magazine*, and, as the point in dispute affected the interpretation of a far wider area than the Tygerberg locality, he (Dr. Rogers) spent a week in the country between Prince Albert and the east end of the Tygerberg, in order to study the evidence for Dr. Sandberg's views. It seemed to him that the

anticlinical structure of the range was clear, for at many places in it the Witteberg beds were seen to dip under the Dwyka on either side. The masses of quartzite in the Dwyka described by Dr. Sandberg appeared to be parts of that formation, *i.e.*, originally sandy sediments with few or no pebbles, formed at the same time as part of the tillite. Similar quartzites in the Dwyka had been described from several localities in the south of the Colony. An examination of Sand River Valley showed not only that it was extremely unlikely that a mass of Witteberg beds underlay the surface, for those beds were not known to form valleys like that of Sand River, but that where outcrops of rock *in sitû* occurred, they belonged to the Ecca Series. He had come to the conclusion that it was unnecessary to assume the presence of a great overturned fold to account for the appearances at Tygerberg, and that the earlier observers were quite justified in ascribing an anticlinical structure to the range.

LIST OF FELLOWS AND MEMBERS.

MEMBERS OF COUNCIL.

S. S. Hough, *President*.

T. Muir.
H. Bolus, *Treasurer*.
R. Broom.
G. S. Corstorphine.
W. Cullen.
A. Theiler.
J. D. F. Gilchrist.
R. T. A. Innes.
T. Reunert.
L. Peringuey, *General Secretary*.

HONORARY FELLOWS.

Rev. C. H. R. Fisk, *C.M.Z.S.*
Sir David Gill, *K.C.B.*, *LL.D.*, *F.R.S.*
Lord Milner.
A. Raffray.
H. G. Seeley, *F.R.S.*
R. Trimen, *F.R.S.*

FELLOWS.

Anderson, A. J., *M.A.*, *M.B.*, Town House, Cape Town.
Beattie, J. C., *D.Sc.*, *F.R.S.E.*, South African College, Cape Town.
Behr, H. C., P.O. Box 1167, Johannesburg.
Bohle, H., *M.I.E.E.*, South African College, Cape Town.
Bolus, H., *D.Sc.*, *F.L.S.*, Kenilworth, C. C.
Broom, R., *M.D.*, *D.Sc.*, Victoria College, Stellenbosch, C. C.
Burtt-Davy, J., *F.L.S.*, Agricultural Department, Johannesburg.
Caldecott, W. A., *B.A.*, *F.C.S.*, P.O. Box 1167, Johannesburg
Corstorphine, G. S., *B.Sc.*, *Ph.D.*, P.O. Box 1167, Johannesburg.
Crawford, L., *M.A.*, *D.Sc.*, *F.R.S.E.*, South African College, Cape Town.
Cullen, W., Dynamite Factory, Modderfontein, Transvaal.
Gilchrist, J. D. F., *M.A.*, *B.Sc.*, *Ph.D.*, South African Museum, Cape Town.
Hahn, P. D., *Ph.D.*, *M.A.*, South African College, Cape Town.
Halm, J. K. E., Royal Observatory, C. C.
Hough, S. S., *M.A.*, *F.R.S.*, Royal Observatory, C. C.
Innes, R. T. A., *F.R.A.S.*, Meteorological Department, Johannesburg.
Ingle, H., *F.I.C.*, *F.C.S.*, 33, City Road, Birmingham.
Kynaston, H., Geological Survey, Pretoria.
Lehfeldt, R. A., *B.A.*, *D.Sc.*, Transvaal University College, Johannesburg.
Lounsbury, C. P., *B.Sc.*, Department of Agriculture, Cape Town.
Marloth, R., *Ph.D.*, *M.A.*, Church Street, Cape Town.
Moir, J., *M.A.*, *D.Sc.*, *F.C.S.*, Mines Department, Johannesburg.
Morrison, J. T., *M.A.*, *B.Sc.*, *F.R.S.E.*, Victoria College, Stellenbosch, C. C.
Muir, T., *C.M.G.*, *LL.D.*, *F.R.S.*, Department of Education, Cape Town.
Neville, E., *F.R.S.*, *F.R.A.S.*, The Observatory, Durban.
Ogg, A., *M.A.*, *B.Sc.*, *Ph.D.*, Rhodes University College, Grahamstown.
Pearson, H. H. W., *M.A.*, *Sc.D.*, *F.L.S.*, South African College, Cape Town.
Péringuey, L., *D.Sc.*, *F.E.S.*, *F.Z.S.*, South African Museum, Cape Town.
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MINUTES OF PROCEEDINGS

OF THE

ROYAL SOCIETY OF SOUTH AFRICA.

Ordinary Monthly Meeting.

March 17, 1909.

Dr. Wm. Flint in the Chair.

Messrs. E. W. Davy, W. Jardine and A. R. E. Walker were nominated for Ordinary Membership.

The following communications were read:—

"The Spectrum of the Ruby." A new characteristic test by J. Moir, F.R.G.S.

On placing a ruby before the slit of a spectroscope, using strong illumination, preferably sunlight, a very remarkable absorption-spectrum is obtained, which differs from all others in resembling an ordinary *emission* spectrum. The light is cut off except for a sharp narrow red band situated just beyond the B line of the solar spectrum, and this band bears the closest resemblance to the potassium or lithium line as commonly seen in the Bunsen flame when a rather wide slit is used. The limiting wave-lengths of the band are about 6,915 and 6,945 centimetres. Its width is therefore about half its distance from the B line in the solar spectrum. The phenomenon is most easily seen in pale rubies; corundum with even the faintest pink shade generally shows the characteristic line; but even the darkest true rubies show it if the illumination be strong enough. No other pink or red stone—pyrope, almandine, spinel, or tourmaline for example—shows this line, which would therefore appear to be characteristic of the colouring of the true ruby. In addition to the red line the spectrum contains wide green and orange bands which are, however, not characteristic.

"Remarks on some Experiments with the Venom of South African

Snakes," by W. Frei. Communicated by A. Theiler, F.R.S., South Africa.

The author contends that from a toxicological standpoint the classification of the snakes in (1) *Oglypha;* (2) *Opistoglypha;* (3) *Proteroglypha;* (4) *Solenoglypha*, is the most satisfactory.

With regard to the question which of the doubtful South African snakes, chiefly *Opistoglypha*, are poisonous or harmless, only a preliminary answer can be given, owing to the experiments not being numerous enough. Five kinds of snakes were experimented with in that section. The difference in the *postmortal lesions* produced by the three venomous families of snakes are the following: *Opistoglypha.*—No pathological-anatomical alteration at all; the poison is a simple one, a mere *neurotoxine. Proteroglypha.*—Local hæmorrhages, slight hæmolysis; the poison consists of two components, a neurotoxine and a hæmotoxine. *Solenoglypha.*—Local hæmorrhages and necrosis, hæmolysis. Besides the neurotoxine there is a strong hæmotoxine which dissolves red blood corpuscles. It is yet doubtful whether the necrosis is due to a special component of the poison. Perhaps the hæmolysine is able to destroy besides erythrocytes other cells like hæmolytic sera which at the same time cause necrosis.

"Note on a Theorem regarding a Sum of Differential-coefficients of Principal Minors of a Jacobian," by T. Muir.

"An Upper Limit for the Value of a Determinant," by T. Muir.

"Note on a Cœnurus of the Duiker Bok," by L. H. Gough.

The parasite was found imbedded in the muscles between the scapula and the vertebral column of a Duiker Bok (*Cephalophus Grimmi*). In view of the small number of intermuscular *Cœnurus* recorded from ruminants a full description of the present one, which differs from *Cœnurus serialis*, is given.

"The Evolution of the River System of Griqualand West," by A. L. du Toit.

The drainage system in the area dealt with consists of the Orange River with its tributaries, the Vaal, Harts, Riet and Brak Rivers, sections of the first three forming the continuous valley facing the edge of the Kaap Plateau from Vryburg almost to Prieska. In Carboniferous times Griqualand West formed portion of a continent which possessed a river system draining in a southerly direction. This continent was glaciated, depressed, and finally buried beneath the sediments of the Karroo system. Intermittent elevation of South Africa during Cretaceous and Tertiary times enabled the rivers to cut plains of erosion or peniplains at various altitudes, the oldest and most important in this area being represented by the Kaap Plateau. The rivers have since cut down and laid bare in this area the floor of older rocks, and the development of the modern river system has been greatly influenced by reason of its superposition upon

that of Carboniferous times. Hence it is that the Harts River, a tributary of the Vaal, now flows for a distance of 100 miles in a channel considerably below the level of the main stream. The Karroo owes its peculiar type of scenery in part to its geological structure and in part to the prolonged nature of the erosion to which it has been subjected.

ANNIVERSARY MEETING.

April 21, 1909.

Dr. A. J. ANDERSON, F.R.S.S.A., in the Chair.

The Secretary read his Report:—

The members of the Society consist of 40 Fellows and 160 Members.

Six Meetings were held during the year, and the following papers read:—

1. "The Pelecypoda from Zululand," by R. B. NEWTON.
2. "A New Variety of *Ixodes pilosus*," by J. G. NEUMANN.
3. "A Note on the Distribution and Hosts of *Ixodes pilosus howardi*," by C. W. HOWARD.
4. "Transvaal Sea Level Temperature," by R. T. A. INNES.
5. "Some Investigations regarding 'Brak' (Alkali)," by C. F. JURITZ.
6. "Contribution to the African Flora," by H. BOLUS and L. KENSIT.
7. "Preliminary Note on the Diurnal Variation of Level at Kimberley," by J. R. SUTTON.
8. "A Diplostigmatic Plant (*Sebacea exocoides*)," by R. MARLOTH.
9. "Some New Species of Euphorbia from South Africa," by R. MARLOTH.
10. "Descriptive Catalogue of the South African Coleoptera. Fam. *Meloïdæ*," by L. PÉRINGUEY.

Page-proofs of these papers, which form Part I. of Vol. I. of the *Transactions* of the Royal Society, 334 pp., illustrated by 24 plates, have been passed, and will be in the hands of the Fellows and Members within six or seven weeks.

The Society has also completed the publication of Vol. XVIII. of the *Transactions* of the South African Philosophical Society, and Part IV. of the said volume, which is just out, contains the following papers:—

"On Rock Engravings of Animals and the Human Figure found in South Africa," by L. PÉRINGUEY.

"Earth Temperature at Kimberley," by J. R. SUTTON.

"Notes on the Bushmen of Basutoland," by S. S. DORNAN, and a list of the contents of the 18 vols. issued by the Philosophical Society.

The Meeting proceeded to the election of the Council, President and Officers in accordance with the procedure prescribed by Statute.

Were elected: S. S. Hough, M.A., F.R.S., President; L. Crawford, M.A., D.Sc., Treasurer; L. Péringuey, D.Sc., Secretary; J. Burtt-Davy, F.L.S.; G. S. Corstorphine, Ph.D.; J. D. F. Gilchrist, M.A., D.Sc.; R. T. Innes, F.A.S.; R. A. Lehfeldt, Ph.D.; C. P. Lounsbury, B.Sc.; T. Muir, LL.D., F.R.S.; A. W. Rogers, M.A., Sc.D.; A. Theiler, M.D.

Ordinary Monthly Meeting.

May 19, 1909.

Dr. L. Crawford in the Chair.

Messrs. E. W. Davy, W. Jardine and A. R. E. Walker were elected ordinary members.

The Secretary announced the names of all candidates proposed prior to the first day of May, *i.e.*, A. L. Hall, E. T. Mellor, Sir Charles Abercrombie Smith, A. L. du Toit, A. M. Wilson.

The following communications were read:—

"On the Possible Existence at Kimberley of Oscillations of Level having a Lunar Period," by J. R. Sutton, M.A., Sc.D., F.R.S.S.Af.

The outstanding seismic feature of Kimberley is the diurnal variation of level whereby the crust of the earth rises and falls once a day under the influence of some solar action as yet uninterpreted. This matter has been discussed in a paper read before the Royal Society of South Africa last July. The present discussion is concerned more with variations of level depending upon the gravitational influence of the moon. The observations do not cover a sufficiently extended period to admit of an exhaustive analysis; but so far as they go they imply perhaps that when the moon is south of the equator its attractive force causes the whole of the enormous protuberant mass of the earth's crust forming South Africa to oscillate periodically east and west during the course of the lunar day. This oscillation tends to mask whatever true lunar tide there may be in the solid earth. Only when the moon is nearest to the earth does the pendulum move in such a manner as to suggest that there is such a tide.

"The Rainfall of South Africa. The Possibility of Prediction over the South-west," by A. G. Howard, M.S.A., communicated by L. Péringuey.

For this investigation, which extended over five complete years, three stations were selected so as to secure a triangle of observations; and at each the rise or fall of the barometer in 24 hours was noted, together

with the direction of the wind at L'Agulhas. From a consideration of the various conditions, which fell under 26 heads, and which were worked out daily during five complete years, it was found possible to construct a table for prediction purposes. This was applied to the rainfall for the year 1908, and the element of error under each condition of barometer was (1) when the pressure was decreasing generally, 5·23 per cent., and (2) when the pressure was increasing generally, about 11 per cent., proving the argument that it is possible to predict rainfall over the district from the data suggested.

Ordinary Monthly Meeting.

June 16, 1909.

Dr. R. Marloth in the Chair.

The Minutes of the last meeting were read and confirmed.

The Secretary, Dr. L. Péringuey, exhibited a newly discovered "post-office" stone. Major-General Scobell kindly allowed the museum authorities to take a cast of a "post office" stone embedded in one of the castle walls. While at work it was found that there was another stone also built into the wall in another part of the castle, and a successful cast of this was taken.

The latter stone bears two inscriptions. The upper reads: Anto Hipon. Ma(ster) of the *Hector*. Boun(d) Home, Januari, 1600, O.P.

Below is a better finished inscription, as follows: Ant. Hippon, Ma(ster) of the *Dragon*, 28 December, 1607.

In a corner in smaller type appear the words: Anthony H.

It would thus appear that the inscriptions record two voyages by the same master. They are the oldest on record. The most ancient one hitherto known is a Danish one dated 1614.

Mr. A. R. Walker exhibited Dinosaurian remains which he recently obtained at Fouriesburg in the O.R.C. They comprised a complete five-toed foot and a complete fore-limb; also replicas in plaster of reptilian footprints, one large and three-toed. The original of the latter was obtained from Tsikoane, Basutoland, and occurred at the junction of the Cave Sandstone and the Red Beds.

The Secretary read two communications from Dr. S. Schönland:—

1. "On some Points in the Morphology and Biology of a New Species of Haworthia." The author gives a full description of *Haworthia truncata*, Schönl.—the only species of Haworthia with strictly distichous arrangement of leaves. The leaves are to a large extent underground,

the exposed parts resembling small pebbles, so that this plant may be classed amongst the so-called "mimicry-plants." The structure of the leaves is adapted to the peculiar mode of life of the plant. The truncate apex is without chlorophyll, thus forming a "window," through which light can reach by way of the central transparent tissue, the assimilating tissue which extends to the underground basal parts of the leaves.

2. "On the Absorption of Water by the Aerial Organs of some Succulents." The author describes numerous experiments from which he has drawn the following conclusions: *Mesembrianthemum barbatum* and *Anacampseros flamentosa* cannot absorb any appreciable quantity of water through their aërial organs. *Crassula cymosa* can do so to a small extent, which, however, cannot be of any practical importance under natural conditions. The marginal papillæ of this species are certainly not water-absorbing organs.

Mr. E. P. Phillips read a "Note on an Abnormal Seedling of *Widdringtonia cupressoides* and a Brief Account of the Vascular System of the Normal Seedling," by H. S. Morris.

Mr. Morris showed a sketch of a twin seedling, the two halves of which were only free from one another for a very short distance above and below.

A second drawing, from a section of the hypocotyl, indicated that the union was a very intimate one, probably dating from the earliest stage of proembryo formation. The vascular systems of the twins were, however, entirely separate and distinct throughout, and their structure agreed with that found in normal seedlings.

It was further found that the vascular system of the normal seedlings differed essentially from that recently described in other species of the genus, indicating a greater simplicity of structure in *Widdringtonia cupressoides*.

Dr. R. Marloth read a paper: "Some New South African Succulents (Part II.)."

Among the succulents described in this paper are a few with a very peculiar structure of their leaves. Last year he exhibited a species of Bulbine with window-leaves, pointing out that such a structure had not been observed as yet on any other plant. The very succulent, nearly egg-shaped leaves of the plant remain embedded in the ground, hence the blunt apex only becomes visible. Here the green tissue is absent, being confined to the sides of the leaf. As the sides are surrounded by soil the light cannot reach them in the ordinary way, but only by entering through the window at the apex, illuminating the leaf from within.

Since then the writer found five other species of plants with such window-leaves. They are all stemless succulents, their leaves remaining embedded in the ground and showing only the flat or convex apex, which

is entirely devoid of green tissue. Hence, as in the case of the Bulbine, the light can reach the green tissue of the leaf only through the window, illuminating the leaf from within.

It is considered that this structure is principally a contrivance for the protection of the green tissue against the destructive action of too severe sunlight.

POSTSCRIPT.—The plant named by Dr. Schönland *Haworthia truncata* in his paper which was read to-night is one of the six species described by Dr. Marloth elsewhere as "window-plants." As his communication was received by the Secretary of the Society before the latter, the author withdraws his diagnosis of the species and cancels the name, in order to avoid a synonym.

ORDINARY MONTHLY MEETING.

July 21, 1909.

Professor R. CRAWFORD in the Chair.

The Minutes of the last meeting were read and confirmed.

The President read the names of the five candidates whom the Council have selected as most eligible, *i.e.*, A. L. HALL, E. T. MELLOR, Sir CHAS. ABERCROMBIE SMITH, A. L. DU TOIT, A. M. WILSON.—Mr. C. H. H. FINCHAM was nominated as ordinary member.

The following communications were read:—

"Notes on the Absorption of Water by Aerial Organs of Plants," by Dr. MARLOTH.

The author explained that he had made numerous experiments with various Karroo plants in order to ascertain whether they are able to absorb water by means of their leaves and thus to utilise the dew, which is of common occurrence in the Karroo every night during the winter. His results showed that some plants possess specially constructed hairs, like *Mesembrianthemum barbatum* and *Crassula tomentosa;* other peculiar stipules, like *Anacampseros Telephiastrum* and *Afilamentosa;* others an unusually modified epidermis, like *Crassula decipiens*, and others again aerial rootlets, like *Cotyledon cristata.* These organs absorb sufficient moisture to supply the requirements of the plants during a part of the year, thus enabling them to exist in arid regions like some parts of the Karroo or the desert coast-belt of Namaqualand.

"Evaporation in a Current of Air (Part I.)," by J. R. SUTTON.

The result of previous observations upon the rate of evaporation made under natural conditions at Kenilworth (Kimberley) with gauges of various patterns suggests that the relative humidity of the air is of more importance than the absolute humidity in determining the loss of water

from a given surface and that there is no simple correspondence between the wind and the evaporation. In this paper the author describes some experiments made to determine the rate of evaporation under different conditions of moisture and temperature in the forced draught generated by an electrically driven fan.

"The Genesis of the Chemical Elements," by JAMES MOIR.

The author has found a new and remarkable relationship between the atomic weights, whereby the accepted values can be calculated with remarkable accuracy. The new scheme brings out closer relationship between such groups as the alkali metals and the halogens, and although it follows the Periodic Law it would require the latter to be modified in important particulars.

"On some Flowering Plants from the Neighbourhood of Port Elizabeth," by S. SCHÖNLAND.

"Statement of Silayi, a Tembu of the Zemba Tribe, with reference to his Life among the Bushmen," by W. E. STANFORD.

This communication contains interesting information about a clan of bushmen whose haunts were in the Drakenberg Mountains, and could muster forty-three men. It is a narrative of cattle-lifting in various ways and devices, as well as of their domestic habits and mode of life; and also of the ultimate destruction of the clan by the Tembu chief.

ANNUAL MEETING.

September 15, 1909.

The President, S. S. HOUGH, Esq., F.R.S., in the Chair.

The following gentlemen were elected ordinary Fellows of the Royal Society of South Africa: A. L. HALL, B.A.; E. T. MELLOR, D.Sc.; Sir CHARLES ABERCROMBIE SMITH, M.A.; A. L. DU TOIT, B.A.; A. MARIUS WILSON, M.D.

After the election the meeting resolved into an ordinary meeting.

Mr. G. H. H. FINCHAM, M.A., was elected an ordinary member.

Were nominated for election as ordinary members: J. M. BAIN, Cape Town, by L. PÉRINGUEY and R. M. LIGHTFOOT; Dr. J. MCLELLAND HENDERSON, by G. S. CORSTORPHINE and L. PÉRINGUEY; J. C. J. KNOBEL, Cape Town, by L. PÉRINGUEY and R. M. LIGHTFOOT; M. LEVISEUR, Bloemfontein, by A. R. WALKER and L. PÉRINGUEY; J. W. MAXFIELD, Stellenbosch, by A. R. WALKER and L. PÉRINGUEY; W. WARDLAW THOMPSON, Cape Town, by J. D. F. GILCHRIST and L. PÉRINGUEY; W. COULSON TREGARTHEN, Colesberg, by L. PÉRINGUEY and R. M. LIGHTFOOT; Dr. AMARAL LEAL, Lourenço-Marques, by C. W. HOWARD and L. PÉRINGUEY; A. J. JANSE, Pretoria, by L. PÉRINGUEY and R. M. LIGHT-

FOOT; C. J. SWIERSTRA, Pretoria, by L. PÉRINGUEY and R. M. LIGHTFOOT; A. E. V. ZEALLEY, A.R.C.S., by A. R. WALKER and L. PÉRINGUEY.

A paper by Dr. T. MUIR, "Borchard's Form of the Eliminant of Two Equations of the *n*th Degree," was taken as read.

ORDINARY MONTHLY MEETING.

October 20, 1909.

The President, S. S. HOUGH, Esq., F.R.S., in the Chair.

The PRESIDENT announced the names of persons recommended for Election as Council and Officers: S. S. HOUGH, President; L. CRAWFORD, Treasurer; L. PÉRINGUEY, Secretary; J. C. BEATTIE; J. BURTT-DAVY; H. KYNASTON; R. A. LEHFELT; C. P. LOUNSBURY; R. MARLOTH; J. MOIR; H. H. W. PEARSON; A. W. ROGERS.

Dr. AMARAL-LEAL; J. M. BAIN; Dr. T. MCLELLAND HENDERSON; J. HEWIT; J. C. J. KNOBEL; A. J. T. JANSE; M. LEVISEUR; J. W. MAXFIELD; W. WARDLAW THOMPSON; W. COULSON TREGARTHEN; A. E. V. ZEALLEY; C. J. SWIERSTRA were elected ordinary members of the Society.

Dr. MARLOTH exhibited some toad-locusts from the Namib, the desert strip of Great Namaqualand, exactly resembling, in colour as well as in form, the gravel or the rocks among which they occur.

"On Nutmeg Poisoning," by Dr. MARIUS WILSON. The symptoms were described and attention called to the small number of cases recorded. As the condiment was used practically throughout the whole world, the explanation must be that a few nutmegs had gone into circulation after germination had begun and then been arrested. In support of this he called attention to the fir seed (dana pitje) which was greatly relished and largely eaten by children near Capetown without any bad results; but when one seed, which has started to germinate, was eaten, the results were very serious and dangerous.

"Observations on some Specimens of South African Fossil Reptiles preserved in the British Museum," by Dr. R. BROOM. The following are some of the conclusions come to by the author:—

All the later specimens which have been referred to *Galesaurus* are held to belong to a different genus and species and must take Owen's name, *Nythosaurus larvatus*.

Gorgonops is held to be closely allied to *Titanosuchus* and to be really a Dinocephalian.

Theriognathus is believed to be very distinct from *Endothiodon* and to be really a Therocephalian.

Anthodon is held to include at present two entirely distinct forms. The type is a small Pareiasaurian from the Permian beds of Styl-Krantz.

The teeth from the Cretaceous bed of the Bushman's River which have hitherto been placed under Anthodon are held to be Dinosaurian, and for them the new name *Palacoscincus africanus* is proposed.

The "Odyssey of our Bushman Boy," by Miss CURRLÉ. It is the narrative of the life of an old boy, "Gert," of the type usually called Bushman at the Cape, partly told by himself, partly by Miss Currlé, whose family the man had been serving for some time. From the events narrated, the man is extremely old, and certain traits of his character and domestic habits are well worth recording now that the race is almost extinct.

"Notes on a Zoological and Botanical Collection from the Group of Islands of Tristan d'Acunha, made by Mr. J. C. KEYTEL, 1908–09," by L. PÉRINGUEY and E. J. PHILLIPS.

The botanical specimens came from Tristan only, while a few birds were obtained from Nightingale Island; the remainder, however, was collected at Tristan itself. Mr. Keytel collected seven of the twenty species endemic to the island, as well as sixteen plants that have been introduced within the last thirty years, as no mention is made of them by Moseley, of the *Challenger* expedition; among the birds was found a cuckoo, a native of South America, *Coccyzus melanocoryphus*. Among the insects all but two are introductions mainly from the Cape, but also from extreme South America. The Cape Crawfish, *Jasus lalandei*, occurs also at Tristan, as well as several fishes found on the Cape Colony coast.

"Absorption of Light by the Atmosphere," by A. W. ROBERTS. The investigation was undertaken for the purpose of obtaining a value of the coefficient of absorption for South Africa. Taking the means of all the results, Dr. Roberts obtains as the value of the coefficient of atmospheric absorption $0^m\ 20$, which interpreted into other terms means that 17 per cent. of all rays that strike the atmosphere perpendicularly are absorbed by the atmosphere.

"The Age of Stone (Palæolithic) in the Drakenstein Valley and the Manner in which the Implements were Made," by L. PÉRINGUEY. A large collection of implements of a huge size were exhibited. It was found possible from the material found in that valley to reconstruct the artificial working of those implements from the fractured, water-worn quartzite boulder to implements of a finish equal to the best Acheulean. The division of Chellean, Acheulean, Mousterian cannot be adopted in South Africa, as the three typical forms were found together and in all stages of finish. The extreme antiquity of the implements shown was demonstrated by the well-nigh disintegrating sandstone of which they are made, as well as by the abraded edges of many of these palæoliths. In fact, some that had been long exposed seem to be preserved by the patina they acquired through the exposure.

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TRANSACTIONS

OF THE

ROYAL SOCIETY OF SOUTH AFRICA.

VOL. I.

CRETACEOUS GASTROPODA, AND PELECYPODA FROM ZULULAND.

By R. Bullen Newton, F.G.S.,
British Museum (Natural History).

(Plates I.–IX.)

CONTENTS.

(A.)—INTRODUCTION.

This communication deals with a number of Cretaceous Gastropods and Pelecypods which were obtained from localities situated in the littoral areas of Zululand, by Mr. William Anderson, F.G.S., during his tenure of office as Government Geologist of Natal between the years 1903 and 1905. Subsequently, the specimens

were presented to the British Museum with a request from Mr. Anderson that they should be critically examined and a published report issued upon them—a work which has now been accomplished as one of my official duties in the Geological Department of that Institution.

The particular districts of Zululand which have yielded these fossils, and which will be presently referred to in detail, are—

(1) The Tributaries of the Manuan Creek.

(2) North End of False Bay.

(3) Umkwelane Hill.

Mr. Robert Etheridge has already made us acquainted with a Cretaceous fauna from Umkwelane Hill, so that the few specimens from that locality found in the present collection are of interest as additional species. The same author has also described Cretaceous fossils from the Umsinene River district, another area of Zululand.

Beside these contributions, Mr. G. C. Crick, has given us a comprehensive account of the Cretaceous Cephalopoda collected by Mr. William Anderson from the same districts of Zululand as have yielded the specimens described in this report. So far as researches have gone, the hitherto published material on this subject conclusively proves the presence of Upper Cretaceous rocks in that country—a fact fully confirmed by an examination of the present collection.

Before concluding the preliminary statement, I should wish to offer my thanks to Mr. Arthur W. Rogers, M.A., Director of the Geological Survey of Cape Colony, for the interest he has taken in this memoir by arranging for its publication in one of the leading scientific journals of South Africa.

I desire, also, to acknowledge my indebtedness to Mr. G. C. Crick, F.G.S., my colleague at the British Museum (Natural History), for his kindness in designing the geological map of the littoral areas of Zululand (an adaptation from that originally published by Mr. Anderson), in which the Cretaceous regions are so well displayed, and which has been reproduced to form the first of the plates of my work.

Considerable praise should likewise be awarded the artist, Mr. A. H. Searle, for the beautiful lithographic plates which accompany this report.

(B.)—LITERATURE ON THE CRETACEOUS PALÆONTOLOGY OF ZULULAND AND SURROUNDING AREAS OF SOUTHERN AFRICA.

Zululand.

Although much is known concerning the Cretaceous faunas of Natal, Pondoland, and neighbouring regions of South-eastern Africa, we are indebted almost entirely to Mr. Anderson for our earliest knowledge of the Cretaceous areas of Zululand.* His researches on this subject form a considerable part of three valuable reports, issued from the Surveyor-General's Office at Pietermaritzburg, Natal, in 1901, 1904, and 1907, the second and third containing special monographs on the Cretaceous fossils by Mr. R. Etheridge and Mr. G. C. Crick.

In the first report † the Cretaceous outcrops discovered are stated to occur chiefly in three localities, viz., on the south bank of the Umfolosi River, close to Lake Isitesa and about 20 miles above its mouth, and known as Umkwelane Hill; on the Umsinene River, some miles to the west of the north end of False Bay, a portion of St. Lucia Lake; and in the bed of the creek, about two miles to the east of Crossly's Store, Bombeni, near the southern end of the Lembombo Range, known as the Manuan Creek district.

The same work mentions the Cretaceous rocks as in all cases resting "unconformably on the formations underneath. From their occurrence and disposition along the littoral it is evident that, after the main elevation of the southern part of the continent, they were deposited as a fringe around the eastern and south-eastern coasts, and their outcrops are now exposed on the land, through the slow continuation of the elevating forces which are still imperceptibly raising the coast-line of Zululand and Natal."

Fuller particulars of these fossiliferous localities will now be given.

Umkwelane Hill.—The following extract from Mr. Anderson's "First Report" (p. 49) gives details of the Umkwelane Hill deposits, which yielded the first recorded Cretaceous fossils from Zululand, and which form the subject of a memoir by Mr. R. Etheridge in the "Second Report."

"Between the Lower Umfolosi River and the Isitesa Lake, there is an outcrop of Cretaceous rocks which form the Umkwelane Hill. The fossiliferous bed is an impure limestone of a bluish grey colour,

* Cretaceous deposits in the region of St. Lucia Bay had been previously recognised by the late Mr. C. L. Griesbach, but without palæontological evidence (*Quart. Journ. Geol. Soc.*, 1871, vol. 27, p. 61).

† **Anderson, W.**—First Report of the Geological Survey of Natal and Zululand. Pietermaritzburg, 1901, p. 47.

which outcrops near the bottom of the eastern slope of the hill. It is overlaid by an earthy-coloured calcareous sandstone, which forms the summit of the hill, and bears a close resemblance to the rock at the Umsinene River, except that in the Umkwelane rock I saw no traces of fossils. The limestone is uniformly fossiliferous, and, usually, the fossils predominate over the matrix. The most common forms are the Lamellibranchiata and Gasteropoda, while the Cephalopoda are rather rare. Polyzoa are very rare, and only occasional fish teeth are to be found."

Mr. Etheridge is of opinion that "the fauna of the Umkwelane Hill deposit consists, with few exceptions, of bivalves and univalves, like that of Griesbach's stratum *b*, and some of the species are identical with those met with in the latter. There appears to be a close connection between the fossils of the two beds; possibly they may actually be on the same horizon." Mr. Henry Woods * who has studied collections from Pondoland, which include Baily's † and Griesbach's ‡ specimens from the Umtamvuna and Umzambani beds, considers that the Umkwelane fossils may be correlated with them, and moreover recognised as belonging to the Campanian or the lower stage of the Upper Senonian division of the Cretaceous system.

In opposition to this statement, however, we find that M. Lemoine § had previously regarded a part of the Umkwelane Hill deposits which he stated contained *Mortoniceras*, *Anisoceras*, &c., as analogous to the Utatur fauna of Southern India and consequently of Vraconnian or Cenomanian age.

Mr. Etheridge's memoir on this deposit mentions nothing about the occurrence of *Mortoniceras*, and it is not until the publication of Mr. Crick's ‖ work on the Cretaceous Cephalopoda of Zululand that we hear of a specimen of that genus having been obtained from Umkwelane Hill.

Mr. Anderson's "Second Report" is, therefore, important as containing Mr. Etheridge's ¶ monograph on the fossils from

* **Woods, H.**—The Cretaceous Fauna of Pondoland. *Annals South African Museum*, 1906, vol. 4, part vii., p. 347.

† **Baily, W. H.**—Description of some Cretaceous Fossils from South Africa, collected by Capt. Garden of the 45th Regiment. *Quart. Journ. Geol. Soc.*, 1855, vol. xi., plates xi.–xiii., pp. 454–465.

‡ **Griesbach, C. L.**—On the Geology of Natal, in South Africa. *Quart. Journ. Geol. Soc.*, 1871, vol. 27, plates ii., iii., pp. 53–72.

§ **Lemoine, P.**—Études Géologiques dans le Nord de Madagascar, 1906, p. 396.

‖ **Anderson, W.**—Third and Final Report of the Geological Survey of Natal and Zululand, 1907, p. 228.

¶ **Etheridge, R.**—Cretaceous Fossils of Natal collected by Mr. William Anderson, Government Geologist. Part I. The Umkwelane Hill Deposit: W. Anderson's Second Report of the Geological Survey of Natal and Zululand, 1904. [London.] Plates i.–iii., pp. 71–93.

Umkwelane Hill, the following forms being listed in the order of their description :—

PELECYPODA.

Ostrea spp.
Exogyra sp.
Neithea sp.
Melina andersoni, sp. nov.
Gervillia spp.
Pinna sp.
Mytilus sp.
Trigonia umkwelanensis, sp. nov.
Trigonarca umzambaniensis, Baily sp.
Latiarca (?) *natalensis*, Baily sp.
Cardium bullen-newtoni, sp. nov.
Protocardium hillanum, J. Sowerby sp.
  var. *umkwelanense*, var. nov.
Eriphyla lenticularis, Goldfuss
Eriphyla (?) *rupert-jonesi*, sp. nov.
Cytherea (?) *kaffraria*, sp. nov.
Cicatrea sp. ind.
Tapes sp.
Donax andersoni, sp. nov.
Mactra (?) *zulu*, sp. nov.
Corbula sp. ind.

GASTROPODA.

Alaria (?) *bailyi*, sp. nov.
Fulguraria sp. ind.
Zaria bonei (?) Baily sp.
Pyropsis (?) *sp. ind.*
Patella (?) *sp. ind.*
Cylichna griesbachi, sp. nov.
Cylichna fusuliniformis, sp. nov.
Actæonina atherstonei, Sharpe
  var. *umkwelanensis*, var. nov.
Gyrodes (?) *sp. ind.*
Chemnitzia sp. ind.
Solarium sp. ind.

CEPHALOPODA.

Placenticeras kaffrarium, sp. nov.
Placenticeras umkwelanense, sp. nov.
Creniceras (?) *sp. ind.*

Mortoniceras umkwelanense,* G. C. Crick
Hamites or *Anisoceras*.
Baculites (?)

PISCES.

Lamna (type) *appendiculata*, Agassiz

Umsinene River.—The "Third Report" contains a further memoir on some Cretaceous fossils by Mr. Etheridge, the specimens being obtained from "The Umsinene River Deposit." This locality and the character of the beds are described by Mr. Anderson on p. 58 of the Report as follows: The name given to these beds "does not describe accurately the position of the deposit from which the fossils that are described came, but owing to the fact that there are four fossiliferous deposits all in a small portion of the Manuan Creek basin, the name 'Umsinene deposit' refers to the deposit occurring immediately to the north of the crossing of the most southerly tributary of the Manuan Creek."

"The outcrop of the 'Umsinene Deposit' is of limited extent, and is exposed chiefly in the bed of the southernmost tributary of the Manuan Creek, and on the rising ground to the north of it, and it again appears where the wagon-track crosses the next spruit to the north. The rock is a calcareous, argillaceous, fine-grained sandstone of a brownish colour, with fossils scattered sparingly through it."

From an examination of these fossils Mr. Etheridge † (p. 89) concludes that "the general facies of the Umsinene fossils resembles that of the Umkwelane Hill bed; I am induced, therefore, to regard them simply as horizons in one and the same geological series."

The fossils are described in the following order:—

ECHINODERMATA.

Hemiaster (?) *sp.*

ANNELIDA.

Serpula pinchiniana, Tate
var. *umsinenensis*, var. nov.

* This Cephalopod is included here to make the list more complete, having been described and figured by Mr. G. C. Crick, subsequent to the publication of Mr. Etheridge's monograph, see Anderson's "Third and Final Report," 1907, pl. 15, fig. 9, p. 228.

† **Etheridge, R.**—Cretaceous Fossils of Natal collected by Mr. William Anderson, Government Geologist. Part II. The Umsinene River Deposit: W. Anderson's "Third and Final Report of the Geological Survey of Natal and Zululand." [London.] 1907. Plates i.–vi., pp. 67–90.

PELECYPODA.

Ostrea spp.
Neithea quinquecostata, J. Sowerby sp.
Entolium (?) *andersoni*, sp. nov.
Pseudavicula (?) *africana*, sp. nov.
Gervillia dentata (?) Krauss
Inoceramus volviumbonatus, sp. nov.
Axinæa subauriculata (?) Forbes
Cucullæa (?) *umsinenensis*, sp. nov.
Trigonia ventricosa, Krauss sp.
Protocardium (?) *cinctutum*, sp. nov.
Astarte herzogii (?) Krauss
Veniella (?) *sanctæ-luciensis*, sp. nov.
Cytherea (?) *sp.*
Pleuromya (?) *sp.*
Myopsis (?) *africana*, sp. nov.
Glycimeris (?) *griesbachi*, sp. nov.
Parapholas tatei, sp. nov.
Teredo (?)—tubes.

GASTROPODA.

Actæon sp.
Zaria (?) *sp.*
Solarium hedleyi, sp. nov.
Pseudamaura terrazulensis, sp. nov.
Alaria (?) *bailyi*, R. Etheridge fil.

CEPHALOPODA.

Douvilleiceras (?) *nodosa*, sp. nov.
Desmoceras sp.
Hamites (?) *sp.*

North End of False Bay.—Concerning this locality Mr. Anderson states on p. 60 of the "Third Report": "The other fossiliferous Cretaceous deposits which I have been able to visit and make collections from, are situated near the junction of the Manuan and the Umsinene Rivers. The exposure shows a thicker series of beds than in any other locality from which I have collected. There are from 70 to 100 feet of strata exposed, chiefly calcareous sandy shales and sandstones, the whole being capped by a very hard calcareous sandstone full of broken shells. The beds are exposed almost continuously where the bank is precipitous. They are exceedingly prolific in fossils, chiefly Mollusca, Cephalopoda, and Gasteropoda. The Cephalopoda are extremely abundant, and range in size from

forms of half an inch to over a yard in diameter. The fossils weather from the shales in a perfect condition, but from long exposure on the surface to the atmosphere, rains, and bush fires, they are largely composed of casts. Some good specimens, however, were obtained," which in Mr. Anderson's "Third and Final Report" were described and figured by Mr. G. C. Crick under the subtitle of "The Cephalopoda from the Deposit at the North End of False Bay, Zululand." Mr. Crick regards this fauna as "undoubtedly of Cenomanian age," and showing a resemblance to that found in the rocks of Northern Madagascar of a similar age, and with that characterising the Utatur group of deposits in the Trichinopoly district of Southern India.

The following are described and mostly figured:—

AMMONOIDEA.

Phylloceras velledæ (? Michelin, sp.) Stoliczka sp.
Phylloceras cf. ellipticum, Kossmat
Gaudryceras aff. sacya, Forbes sp.
Gaudryceras odiense, Kossmat
Tetragonites timotheanus (? Mayor, sp.).
Turrilites scheuchzerianus, Bosc
Turrilites costatus, Lamarck
Turrilites acutus, Passy
Turrilites nodiferus, sp. nov.
Baculites sp.
Knemoceras (?) *cornutum*, sp. nov.
Forbesiceras largilliertianum, Orbigny
Forbesiceras sculptum, sp. nov.
Forbesiceras nodosum, sp. nov.
Acanthoceras flexuosum, sp. nov.
Acanthoceras crassiornatum, sp. nov.
Acanthoceras munitum, sp. nov.
Acanthoceras expansum, sp. nov.
Acanthoceras robustum, sp. nov.
Acanthoceras sp.
Acanthoceras quadratum, sp. nov.
Acanthoceras hippocastanum, J. de C. Sowerby sp.
Acanthoceras latum, sp. nov.
Acanthoceras newboldi, F. Kossmat
Acanthoceras newboldi, var. *spinosa*, Kossmat
Acanthoceras laticostatum, sp. nov.
Acanthoceras nitidum sp. nov.
Acanthoceras paucinodatum, sp. nov.

Acanthoceras choffati, Kossmat
Acanthoceras aff. choffati, Kossmat
Acanthoceras cornigerum, sp. nov.
Desmoceras sp. (cf. *latidorsatum*, Michelin sp.).
Desmoceras inane, Stoliczka
Puzosia planulata, J. de C. Sowerby sp.
var. *natalensis*, var. nov.
Puzosia subcompressa, sp. nov.
Puzosia stoliczkai, Kossmat
Puzosia subtilis, sp. nov.
Puzosia pinguis, sp. nov.

NAUTILOIDEA.

Nautilus imbricatus, sp. nov.
Nautilus striatocostatus, sp. nov.
Nautilus ovoideus, sp. nov.
Nautilus occlusus, sp. nov.

Tributaries of the Manuan Creek.—The deposits of this area are thus described by Mr. Anderson on p. 59 of the "Third Report": "The next deposit occurs on the middle tributary of the Manuan Creek to the north. Where the wagon-track crosses this creek the rock is Rhyolite, which persists right to the source of the creek. Below the crossing the right-hand bank is entirely of Rhyolite, while on the left-hand bank a small outcrop of fossiliferous Cretaceous rocks occurs, which is exposed in a mealie garden belonging to the neighbouring kraal. The outcrop is a very small outlier, exposed on the slope of the northern bank of the creek, and is completely isolated on the Rhyolite. This exposure passes along the north side of the creek for a distance of a few hundred yards. The strata, as exposed in the cliff, which is about 20 feet in height, consists of a dirty grey-brown calcareous sandstone, which contains the chief specimens of the Cephalopoda, both Ammonites and Nautili. Below this, about 15 feet of shales and marls, chiefly containing Mollusca and other forms." The Cephalopoda here referred to have been described by Mr. G. C. Crick in Mr. Anderson's "Third and Final Report" under the sub-title of "The Cephalopoda from the Tributaries of the Manuan Creek, Zululand."

Mr. Crick considers these specimens as belonging "to the same series of beds as the False Bay fossils," although some "probably represent a somewhat higher horizon (possibly Senonian)," whilst others "seem to show the existence there of either a lower portion of the beds which are exposed at False Bav, or even a slightly lower horizon."

The forms described and figured are as under:—

AMMONOIDEA.

Phylloceras sp.
Lytoceras crenulatum, sp. nov.
Gaudryceras pulchrum, sp. nov.
Gaudryceras spp.
Anisoceras sp.
Baculites.
Schlœnbachia spp.
Acanthoceras sp.
Desmoceras sp.
Hauericeras spp.
Puzosia concinna, sp. nov.
Puzosia compacta, sp. nov.
Hysteroceras sp.

NAUTILOIDEA.

Nautilus manuanensis, sp. nov.
Nautilus spp.

Some more northern districts of Zululand are also alluded to by Mr. Anderson in his "Third and Final Report" (p. 61) as exhibiting Cretaceous outcrops, but as no fossils were collected they need not be further remarked upon in this paper.

The distribution of the Cretaceous rocks in Zululand, as recorded by Mr. William Anderson, are again referred to in an interesting paper by Mr. G. C. Crick,* and particularly in connection with the Cephalopod fauna which he had recently described from that country.

GERMAN EAST AFRICA.

Kigua, &c.—The Cretaceous fauna of German East Africa has been mainly described by Dr. Gottfried Müller † from material collected by the W. Bornhardt expedition of 1895–1897. In the most northern area of this region, at Kigua, about 40 kilometres from the coast town of Bagamoyo opposite the island of Zanzibar, Cenomanian fossils were found including:—

Vola quinquecostata, J. Sowerby, sp.
Vola cf. striato-costata, Goldfuss sp.
Exogyra columba, Lamarck

* **Crick, G. C.**—The Cretaceous Rocks of Natal and Zululand and their Cephalopod Fauna. *Geological Magazine*, 1907, pp. 339–347, with sketch geological map.

† **Müller, Gottfried.**—Versteinerungen des Jura und der Kreide: W. Bornhardt's "Deutsch-Ost-Afrika." [Berlin.] 1900. Vol. 7, pls. 19–25, pp. 540–571.

Further south, the province of Mtunha, 81 kilometres S.W. of Dar-es-Salam (on the coast), has yielded remains of *Radiolites cf. angeoides*, Lamarck, which are regarded as of Senonian age.

Near Minguina-Bache, 27 kilometres W.N.W. of the costal town of Kilwa Kwindye, Turonian rocks have been determined, from the occurrence in them of the genus *Monopleura*.

Still further south, at Mtshinga, Ntandi, the Litshibu Plateau, &c., Neocomian beds occur containing *Trigonia ventricosa*, Krauss, *Ostrea minos*, Coquand, *Gervillia dentata*, Krauss, *Vola atava*, F. A. Römer sp., *Cardium cottaldinum*, Orbigny, *Pholadomya gigantea*, J. de C. Sowerby, *Belemnites binervius*, Raspail, &c., &c. These deposits are of corresponding age to those of the Uitenhage district of Cape Colony.

Portuguese East Africa.

Conducia (Mozambique area).—Beyond the limits of Zululand, the littoral regions of Portuguese East Africa in the north as well as those characterising Natal and Pondoland in the south have been long known to possess Cretaceous strata. The late Professor Neumayr * figured and described, probably, the earliest known Cretaceous fossil from Portuguese Africa under the name of *Phylloceras semistriatum* of Orbigny, the specimen having been collected by Peters in 1843 from rocks near the mouth of the river Conducia, opposite the small island of Mozambique, in the Indian Ocean. Beyrich, who was familiar with this Ammonoid, regarded it as of probably Neocomian age, the same horizon being adopted by Neumayr in his published account. A more complete fauna from the same area of Portuguese Africa has since been described by M. Paul Choffat.† This consists chiefly of Cephalopoda, among the specimens being some fragmentary remains of Neumayr's *P. semistriatum*, associated in the same matrix with a form of *Pachydiscus conduciensis*, Choffat, and which is determined as *Phylloceras cf. semistriatum*, d'Orbigny. Choffat remarks on certain resemblances existing between Peters' specimen and Stoliczka's *Phylloceras velledæ* from the Utatur group of Southern India. Mr. G. C. Crick ‡ has quite recently recognised *P. velledæ* in the Cenomanian rocks of the north end of False Bay, Zululand,

* **Neumayr, M.**—Die Geographische verbreitung der Jura formation. *Denkschr. K. Akad. Wiss.* [Wien], 1885, vol. 50, pl. 1, fig. 2, p. 139.

† **Choffat, P.**—Le Crétacique de Conducia, *Contrib. Connais. Géol. Colonies Portugaises Afrique* [Lisbon], 1903, p. 17.

‡ **Crick, G. C.**—The Cephalopoda from the Deposit at the North End of False Bay, Zululand: Anderson's "Third and Final Report of the Geological Survey of Natal and Zululand," 1907, p. 169.

and under the same subject discusses the merits of Neumayr's shell, stating that "it is possible that the Conducia specimens are specifically identical with Indian examples referred to *Phylloceras velledæ.*"

There appears to be every reason to assume, therefore, that Neumayr's specimen has been wrongly determined, and that instead of its being of Neocomian age, it really belongs to the Vraconnian-Cenomanian series, to which M. Choffat refers the Conducia fauna.

Sofala.—South of the Conducia area, Sofala appears to be the next locality of importance where Upper Cretaceous (= Senonian) rocks have been discovered, Mr. David Draper having brought home a specimen of *Alectryonia ungulata*,* which proved the existence of those deposits in that region.

From the valley of the Busi River, in the same neighbourhood, M. Paul Choffat† has determined another example of the same oyster associated with *Exogyra columba* and some other less definite remains, all of which are of Upper Cretaceous age.

Delagoa Bay (district of Lorenzo Marques).—From the district of Lorenzo Marques, in Delagoa Bay, M. Kilian‡ has reported the occurrence of Aptian fossils belonging to such forms as: *Hamites royerianus*, Orbigny, *Acanthoceras martini* var. *albrechti-austriæ* Hoh., *Oppelia nisus*, Orbigny, *Ancyloceras*, *Anomia lævigata*, J. de C. Sowerby, *Pinna cf. robinaldina*, Orbigny, &c.

The completed memoir on this subject will be welcomed by all palæontologists, as it is exceedingly interesting to find so old a fauna coming between the two Upper Cretaceous areas of Sofala in the north and the False Bay region of Zululand in the south.

Natal.

Umpenyati River.—One of the earliest references to the Cretaceous fauna of Natal is to be found in the "Handbook" § of that country, issued during 1886 in connection with the "Colonial and Indian Exhibition," where a brief statement is made on the rocks of Alfred County as follows:—

* **Newton, R. B.**—On the occurrence of *Alectryonia ungulata* in S.E. Africa; with a notice of previous researches on the Cretaceous Conchology of Southern Africa. *Journ. Conchology*, 1896, vol. 8. pp. 136–151.

† **Choffat, P.**—Le Crétacique de Conducia, *Contrib. Connais. Géol. Colonies Portugaises Afrique*, 1903, p. 7.

‡ **Kilian, W.**—Ueber Aptien in Südafrika, *Centralbl. Min. Geol. Pal.*, 1902, pp. 465–468.

§ **Anon.**—Colonial and Indian Exhibition, 1886, Natal. Official Handbook [London], 1886, p. 31.

"The chalk formation is represented by a deposit of small extent on the sea-coast in Alfred County, which is rich in organic remains bearing easy comparison with those found in the chalk deposits of India."

The Cretaceous fossils of Natal appear to be restricted to the region forming the mouth of the Umpenyati River, situated in the most southern province, known as Alfred County, that is if we except a Cephalopod which has been described as coming from Port Natal, the locality of which has been questioned by Mr. Anderson on p. 50 of his "Third and Final Report." The specimen concerned was described and figured by the late Professor Hyatt * as *Eulophoceras natalense* from the Upper Cretaceous rocks of Port Natal, but Mr. Anderson knows of no Cretaceous outcrops on the present land surface at that place, hence he thinks the fossil must have been brought to the port, although originally collected either from near the mouth of the Umpenyati River or from the Pondoland deposits.

In the rocks of the Umpenyati region Mr. Anderson (p. 50, "Third and Final Report") has determined the presence of *Hemiaster forbesi*, Baily, a number of Pelecypods, Gastropods, and Cephalopoda, as well as Vertebrate remains; the entire fauna being of precisely the same facies as characterises the Upper Cretaceous deposits of Pondoland, forming an extension, therefore, of the Umtamvuna or Umzamba beds (of A. W. Rogers and E. H. L. Schwarz) of that province. Special notices have also been written on the Vertebrates in the "Third and Final Report," Professor Broom † dealing with the Reptilian fauna and Dr. A. S. Woodward ‡ with the Fish remains. In addition an Ammonite has been described by Mr. G. C. Crick § from this same locality.

Pondoland.

Umtamvuna River, &c.—The Cretaceous rocks of Pondoland were first noticed by Captain R. J. Garden || as occurring near the Umta-

* **Hyatt, A.**—Pseudoceratites of the Cretaceous, *Mon. United States Geol. Surv.*, 1903, vol. 44, pl. xi., figs. 2–6, pp. 86, 87.

† **Broom, R.**—On some Reptilian remains from the Cretaceous beds at the mouth of the Umpenyati River, p. 95.

‡ **Woodward, A. S.**—Note on Cretaceous Fish Teeth from the Mouth of the Umpenyati River, pl. x., pp. 99–101.

§ **Crick, G. C.**—Note on a Cretaceous Ammonite from the Mouth of the Umpenyati River, p. 250.

|| **Garden, R. J.**—Notice of some Cretaceous Rocks near Natal, South Africa, *Quart. Journ. Geol. Soc.*, 1855, vol. xi., pp. 453, 454.

funa or Umtamvuna River, as well as in the neighbourhood of the Umzamba or Umzambani River, and extending probably to the Umtata River. The fossils collected by Captain Garden were described and figured by W. H. Baily,* who regarded them as showing affinities to the Southern Indian Cretaceous fossils, which had been monographed by Edward Forbes † in 1846, as well as to the Blackdown fauna of England and the *Craie Chloritée* of France.

Subsequently the late C. L. Griesbach ‡ collected similar and additional specimens from the same localities, his researches forming a valuable contribution to this subject. He termed the fossiliferous beds the "Izinhluzabalungu Deposits," dividing them into five zones, with *Ammonites gardeni* at the top. He regarded the beds as extending as far as St. Lucia Bay in Zululand, and he further considered that the fossils belonged to the Chalk, Upper Greensand, and Lower Greensand horizons, and about twenty of the molluscan species were referred to Southern Indian forms.

Griesbach's types are in the Natural History Museum of Hamburg, and Dr. Gottsche,§ the present Director of that Institution, published a brief statement about them in 1887, his opinion being that the species range from the Utatur to the Ariyalur groups.

Some years since Dr. Franz Kossmat || had the opportunity of examining Baily's original specimens from Pondoland in the Museum of the Geological Society, as well as an important collection from the same country in the British Museum.¶ He proved the inaccuracy of Griesbach's zones by finding examples of *Schlœnbachia stangeri* and *Puzosia gardeni* associated together in the same matrix, and therefore rightly concluded that they must be of similar horizon.

* **Baily, W. H.**—Description of some Cretaceous Fossils from South Africa, &c., *Quart. Journ. Geol. Soc.*, 1855, vol. xi., pls. xi.-xiii., pp. 454-465.

† **Forbes, E.**—Report on the Fossil Invertebrata from Southern India, &c., *Trans. Geol. Soc. London*, 1846. ser. 2, vol. 7, pls. 7-19, pp. 97-174.

‡ **Griesbach, C. L.**—On the Geology of Natal, in South Africa, *Quart. Journ. Geol. Soc.*, 1871, vol. 27, pls. ii., iii., pp. 53-72.

§ **Gottsche, Dr.**—*Zeitsch. deutsch. geol. Ges.*, 1887, vol. 39, p. 622.

|| **Kossmat, F.**—Die Bedeutung der Südindischen Kreide-Formation für die Beurtheilung der Geographischen Verhältnisse während der späteren Kreidezeit, *Jahrb. k. k. Geol. Reichs.* [Wien], 1894, vol. 44, part 3, p. 463. An English translation of this memoir is to be found in the *Records Geol. Surv. India*, 1895, vol. 28, pp. 39-55.

¶ This collection was transferred to the British Museum from the Imperial Institute by the late Director, Sir Frederick Abel, F.R.S., on behalf of the Government of Natal, during 1894, having been found on the site of the "Colonial and Indian Exhibition, 1886," and is doubtless that referred to in the "Natal Official Handbook" of that Exhibition on p. 44, as follows: "Fossils from Chalk Formation, Umtamvuna River. Wm. Bazley."

Griesbach had regarded the first-named Cephalopod as belonging to his zone *d*, which he considered as equivalent to the "Lower Greensand" of Northern Europe, or the Utatur beds of India; whilst the *Puzosia gardeni* he placed in his top zone *f*, which represented the "White Chalk, most probably," of Northern Europe. At this date Kossmat favoured the idea of a Lower Senonian age for this fauna. During 1896,* when reporting the discovery of Upper Cretaceous rocks at Sofala, I contributed a notice of the bibliography of the Cretaceous Conchology of Southern Africa, in which I inadvertently attributed to Dr. Kossmat a tabular list of the Pondoland deposits which he had cited in his paper of 1894. This list was introduced as representing Griesbach's views in connection with the zonal divisions of the beds in question and their correlation with the Southern Indian Cretaceous, from which Dr. Kossmat dissented, he having successfully proved in his memoir the fallacy of such a rendering (see p. 14 of present paper) and the necessity for recognising the series as of Lower Senonian age. Speaking of the Cephalopod fauna of this region, on the same occasion, Dr. Kossmat † stated that "not a single species occurs indicative of an horizon earlier than Lower Senonian." The mistake here alluded to was afterwards rectified by the publication of a "Corrigendum."‡ Subsequently, when writing on the Pondicherri Cretaceous, Dr. Kossmat,§ referring again to the Cretaceous of Pondoland, states that those beds belong to the Upper Trichinopoly and Ariyalur stages of Southern India.

These views were more or less adopted by M. Grossouvre,‖ who was of opinion, chiefly from a study of the Cephalopoda, that the Pondoland deposits were of Lower Senonian age, resembling in parts the Coniacian; as well as admitting the existence of Upper Senonian (Campanian) on account of the presence of *Pseudophyllites indra* and *Gaudryceras kayei.*

Messrs. Rogers and Schwarz ¶ next give a detailed account of their geological examination of the Pondoland Cretaceous deposits, quoting the various fossils they collected, which, as a rule, were

* **Newton, R. B.**—On the Occurrence of *Alectryonia ungulata* in S.E. Africa, with a notice of previous researches on the Cretaceous Conchology of Southern Africa. *Journal of Conchology*, 1896, vol. 8, p. 147.

† **Kossmat, F.**—*Records Geol. Surv. India*, 1895, vol. 28, p. 43 (=English translation of German paper previously quoted).

‡ **Newton, R. B.**—*Journal of Conchology*, 1896, vol. 8, p. 208.

§ **Kossmat, F.**—The Cretaceous Deposits of Pondicherri. *Records Geol. Surv. India*, 1897, vol. 30, p. 71.

‖ **Grossouvre A. de.**—Recherches sur la Craie Supérieure, 1901, pp. 926, 927.

¶ **Rogers, A. W.**, and **E. H. L. Schwarz.**—Annual Rept. Geol. Commission, 1901. Cape of Good Hope, 1902, pp. 38–44.

not restricted to particular beds as previously demonstrated by Griesbach.

Mr. Frederick Chapman * has contributed to the palæontology of Pondoland by publishing a report on the Foraminifera and Ostracoda he was able to identify in the sandy-clays of the Umtamvuna series. He was of opinion that these organisms showed stronger affinities with the Upper rather than with Lower Cretaceous forms, and further, the species denoted shallow water conditions for their environment.

Some interesting particulars are given of the Cretaceous rocks of Pondoland by Mr. A. W. Rogers, Director of the Geological Survey of Cape Colony, in his "Introduction to the Geology of Cape Colony," 1905, p. 318, with a plate of the more characteristic fossils from what he terms the "Umzamba" beds, but which are also known as the "Umtamvuna" series. Included in this account is a note by Mr. F. L. Kitchin on the relationship of the fauna to that of certain beds in India and other countries, his opinion being that the Pondoland fossils should be correlated with those from the Ariyalur (Upper Senonian) stage as developed in the Trichinopoly and Pondicherry districts of Southern India.

A *résumé* of our knowledge of the Cretaceous palæontology of Pondoland, Zululand, and the littoral of Portuguese East Africa is also to be found in "The Geology of South Africa," by Dr. F. H. Hatch and Dr. G. S. Corstorphine, published in 1905 (pp. 253–262), some of the typical fossils being figured.

A valuable report has been recently issued by Mr. H. Woods on the Cretaceous fauna of Pondoland,† in which, after a study of all the principal collections, he concludes that it should be referred to the Ariyalur group or the Campanian stage of the Senonian system. He disagrees with Dr. Kossmat in recognising any part of the fauna as belonging to the upper division of the Trichinopoly group.

Cape Colony.

Uitenhage District, &c.—A brief mention may be made here of the Lower Cretaceous or Neocomian deposits occurring at various places in the southern regions of Cape Colony, particularly at the

* **Chapman, F.**—Foramimfera and Ostracoda from the Cretaceous of East Pondoland, South Africa. *Annals South African Mus.*, 1904, vol. 4, part 5, pl. xxix., pp. 221–237.

† **Woods, H.**—The Cretaceous Fauna of Pondoland. *Ann. South African Mus.* 1906, vol. 4, pls. 33–44, pp. 275–350.

Zwartkop and Sunday River districts, which are in or near the province of Uitenhage. Fossils from these beds have long been known through the researches of Hausmann,* Goldfuss,† Krauss,‡ Daniel Sharpe,§ Tate,|| Holub and Neumayr,¶ &c. Beds of corresponding age are found in German East Africa.

West Africa.

Elobi Islands.—We are indebted to Dr. Szajnocha ** for reporting the presence of *Schlœnbachia inflata*, J. Sowerby sp., in the rocks of the Elobi Islands, a characteristic zonal species of the Lower Cenomanian period, and which Choffat recognises as Vraconnian.

Angola.—An interesting memoir has been published by M. Paul Choffat †† on the littoral regions of Angola where Cretaceous fossils have been discovered belonging to the Albian (*Acanthoceras mammillatum*, &c.), Vraconnian (*Schlœnbachia inflata*), Cenomanian-Turonian (*Inoceramus langi*, Choffat, *Actæonella*, *Cyprina ivensi*, Choffat), and Senonian (*Cardita barronneti*, Munier-Chalmas, *Roudaireia forbesi*, Stoliczka, *Ostrea baylei*, Coquand, *O. olisiponensis ?* Sharpe).

* **Hausmann, J. F. L.**—Gottingische gel. Anzeigen, 1837, part 3, p. 1449.

† **Goldfuss, A.**—Petrefacta germaniæ, 1837 and 1840, vol. 2, pls. 137, fig. 5, and 149, fig. 10, pp. 202 and 239.

‡ **Krauss, F.**—*Nov. Act. Acad. Cæs., Leop.-Carol. Nat. Cur.*, 1850, vol. 22, pls. 47–50, pp. 439–464.

§ **Sharpe, D.**—*Trans. Geol. Soc., London*, 1856, vol. vii., pls. 22, 23, pp. 193–202.

|| **Tate, R.**—*Quart. Journ. Geol. Soc.*, 1867, vol. 23, pls. 7–9, pp. 139–175.

¶ **Holub, E.**, and **M. Neumayr.**—*Denksch. K. Akad. Wiss.*, 1882, vol. 44, pls. 1, 3, p. 267.

** **Szajnocha, L.**— Zur Kenntniss der Mittel-Cretacischen Cephalopoden—Fauna der Inseln Elobi on der Westküste Afrika's. *Denksch. K. Akad. Wiss.*, 1885, vol. 49 pls. 1–4, pp. 231–238.

†† **Choffat, Paul.**—Nouvelles données sur la zone littorale d'Angola. *Contrib. Connais. Géol. Colonies Portugaises Afrique*, 1905, pls. 1–4, p. 48.

(C.)—DESCRIPTION OF THE FOSSILS.

GASTROPODA.*

Family NATICIDÆ.

Genus GYRODES, Conrad, 1860.

Journ. Acad. Nat. Sci. Philadelphia, 1860, new series, vol. 4, part 3, p. 289.

Gyrodes manuanensis, n. sp.

Plate VIII., figs. 9, 10.

Description.—Shell sub-globose large, robust; spire low, depressed in its summit region, composed of five or six moderately inflated volutions posteriorly flattened and excavated; upper margins of whorls obtusely angulate and furnished with small, rather obscure nodulations; body-whorl of considerable size, broader than high, and about five times the depth of the penultimate; basal region occupied with a prominent, wide, and deeply excavated umbilical cavity, which is funnel-shaped and bordered above by a revolving obtuse carina and within by a second revolving ridge which is parallel with it; the walls of the umbilical cavity are ornamented with a crowded series of obliquely curved longitudinal striations, whilst the remaining surface of the shell is covered with numerous prominent lines of growth curving obliquely from the suture over the shoulders of the whorls and extending to the basal margin; there are no spiral striations; aperture perpendicular, elliptical; shell structure of moderate thickness.

Dimensions.—

Height	40 mm.
Breadth	40 ,,
Diameter of aperture	30 × 15 mm.

Observations.—The specimen described, of which there is only one example, is apparently of adult growth, and beyond a few fractures in the neighbourhood of the mouth is remarkably well preserved, a fair amount of the original shell structure being still intact. It forms a good illustration of Conrad's *Gyrodes* (type = *Natica petrosa* of Morton from the Cretaceous of the United States),

* The genera of both the Gastropod and Pelecypod groups of Mollusca mostly follow the order of Pelseneer's classification, as suggested in the *Ann. Soc. Roy. Malac. Belgique*, 1894, vol. 27, pp. 31–243.

which is a Naticiform shell with whorls channelled above and possessing a deep umbilical cavity with no evidence of a callus either on the columella or base. This genus is quite characteristic of Upper Cretaceous rocks, having been recorded from the United States, Europe, Africa, and India.

Mr. Etheridge, jun., has figured some imperfect specimens of this genus from the Umkwelane Hill deposits (Anderson's Second Report of the Geol. Surv. of Natal and Zululand, 1904, pl. 2, fig. 32, pl. 3, fig. 1, p. 88), which he determines as *Gyrodes* (?) *sp. indet.*, but as the important umbilical characters are not shown it is scarcely possible to use such material for purposes of comparison except it might be observed that the specimens are much smaller than the form now described, although having the oblique sculpture lines and a widely channelled suture.

In a similar way Mr. Woods has figured two fragmentary specimens as *Gyrodes sp.* (Cretaceous Fauna of Pondoland: *Annals South African Museum*, 1906, vol. 4, part 7, pl. 38, figs. 9, 10, p. 317), which were collected in the Cretaceous deposits of Pondoland, but these differ in having a less developed umbilical cavity, besides showing a relatively greater width of body-whorl. MM. Thomas and Peron have described some internal casts from the Cenomanian deposits of Algeria and Tunis (Desc. Moll. Fossiles Terr. Crétacés Tunisie, *Explor. Scientif. Tunisie*, 1890, part 1, pl. 19, figs. 19–21, p. 53), under the name of *Natica subexcavata*, which undoubtedly may be referred to *Gyrodes*, but which are easily distinguishable from the Zululand shell by the possession of a narrower and more produced body-whorl, although exhibiting quite as prominent an umbilical cavity. It is interesting to note also in connection with *N. subexcavata* that the authors acknowledge its resemblance to Michelin's European species, *Natica excavata*, a characteristic Albian fossil of France (see Orbigny: Paléontologie Française. Terrains Crétacés. Gasteropoda, 1842, pl. 173, figs. 1, 2, p. 155), which is an excellent example of *Gyrodes*, but with an apparently less developed spiral region and a more oblique aperture than is observed in the present shell. An Indian form has, however, been described by Stoliczka, which perhaps is more closely related to the shell in question than those previously mentioned; this is *Gyrodes pansus*, which ranges throughout the three divisions of the Cretaceous strata—the Utatur, the Trichinopoly and the Ariyalur (Cretaceous Gastropoda, Southern India, *Pal. Indica*, 1868, pl. 22, figs. 9–13, p. 305). The general contour is very similar, so also is the ornamentation, that is if the small thick tubercles of the African shell on the sub-angulate shoulders be regarded as crenulations. It

is chiefly in the basal region where certain differences may be observed, the Indian shell having a much narrower and less developed umbilical region, whilst the aperture is wider and more inclined to obliquity. Again, the traces of a fine spiral punctation in the shell structure referred to in Stoliczka's species are not observable in the specimen from Zululand.

In pointing out the relations of this shell to further forms it may be stated that resemblances can be traced with *Gyrodes euryomphala* of Philippi, sp., which has been determined and figured by Wilckens from the Upper Cretaceous beds of the island of Quiriquina, off Chili (*Neues Jahrb.* Beilage-Band, 1904, vol. 18, pl. 17, fig. 10, p. 198), these deposits being regarded in De Lapparent's "Traité de Géologie," ed. 5, 1906, p. 1467, as of Upper Senonian age. Another form presenting similarity is Meek's *Gyrodes Conradi*, identified by Stanton as a member of the Upper Cretaceous fauna of Colorado (*Bull. United States Geol. Surv.* 1893, No. 106, pl. 29, figs. 7, 8, p. 136), which Dr. Kossmat recognises as of Turonian age, Meek himself having originally described the species from the Fort Benton Group of Dakota Territory (*Rept. United States Geol. Surv. Territories*, 1876, vol. ix., p. 310, woodcuts, figs. 33–36).

Locality.—Tributaries of the Manuan Creek.

Family SCALIDÆ.

Genus SCALA, G. Humphrey, 1797.

Museum Calonnianum [London], 1797, p. 23.

Scala zululandiæ, sp. nov.

Plate VIII., figs. 18, 19.

Description.—Shell elongately conical, acuminate, imperforate; whorls 9–12, plano-convex, moderately deep, finely and distinctly sutured, posteriorly furnished with a bevelled margin embracing the base of previous volution; whorls ornamented with from 15 to 16 thick, rounded, equidistant, curved, longitudinal plications separated by well-channelled interspaces, surface structure composed of minute spiral and longitudinal striations; anterior keel not present.

Dimensions.—

Length	50 mm.
Diameter	19 ,,

Observations.—This form of *Scala* is represented by a single example, which is imperfect at both extremities, parts of the basal and the eight earlier whorls only being preserved, the original number

probably being about twelve. The sculpture characters are well depicted, the thick flexuous costæ assuming a most regular arrangement in conjunction with the wide and prominently channelled interspaces. Some erosion has smoothed the summits of the axial plications, as it is only occasionally the reticulate ornamentation can be observed crossing them. The spiral striations are the most strongly developed, whereas the longitudinal are finer and more numerous. These lines of ornamentation, however, are very difficult to see without the aid of a good lens.

At first sight the specimen roughly resembles such shells as *Scala dupiniana* from the European Albian (Orbigny: Pal. Française Terr. Crétacés, Gasteropods, 1842, pl. 154, figs. 10–13, p. 54), or J. S. Gardner's *S. canaliculata* (*non* Orbigny) from the Barremian beds of Atherfield, in the Isle of Wight (*Geological Magazine*, 1876, pl. 3, fig. 5, p. 107), but from both these species it differs in the possession of flattened or very slightly ventricose whorls, the presence of a bevelled posterior margin, and the absence of an anterior carination.

Baily's *S. ornata* from the Upper Cretaceous of South-East Africa (Pondoland) is also a shell with much more convex whorls than the specimen from Zululand (*Quart. Journ. Geol. Soc.*, 1855, vol. xi., pl. 12, fig. 2, p. 459), nor is this type of *Scala* known in the Cretaceous rocks of either Northern Africa (Egypt, &c.) or Syria.

For very similar reasons the species is not to be confused with any of the forms described by Stoliczka from the Southern Indian Cretaceous deposits (Cretaceous Gastropoda, Southern India, *Pal. India*, 1868, pp. 231–234).

A relationship can be traced with two further species described by Mr. Gardner in the previously mentioned paper of the *Geological Magazine*, called *Pyrgiscus gaultinus* and *P. woodwardi*, both of Albian age, the former having been collected at Folkestone, the other at Blackdown. These shells have depressed whorls, an almost similar sculpture, and obscure traces, especially in *P. gaultinus*, of a bevelled margin to the upper part of the whorl, they are, however, of a less extensive basal diameter, whilst the last whorl is relatively more elongate. As the affinities of the shell are decidedly in favour of association with Gardner's species, it is strongly suggestive evidence that the Albian portion of the Cretaceous system should be recognised as its most probable period of origin. It may be mentioned that for those forms of the Scalidæ possessing depressed whorls, Mr. Gardner adopted Philippi's generic name of *Pyrgiscus*, but as that genus is recognised as a member of the Pyramidellidæ, all of which have one or more folds on the columella and are besides of small size, it is considered more advisable on the present occasion

to regard the shell from Zululand as a singularly depressed form of *Scala*, which, when more is known respecting the characters of the aperture, might eventually be placed under a new generic name.

Locality.—North end of False Bay.

Family ARCHITECTONICIDÆ.

Genus ARCHITECTONICA, J. F. Bolten, 1798.

Museum Boltenianum [Hamburg], 1798, Part 2, p. 78.

Architectonica africana, n. sp.

Plate VIII., figs. 13–15.

Description.—Shell short, summit obtuse, broadly conical, height less than basal diameter; whorls about seven, depressed, gradually widening from nucleus, last about double the width of penultimate, separated by a thin and distinct suture, basal margin obtuse; base plano-convex, furnished with a narrow umbilicus surrounded by a small circular furrow and a radially plicated funnel-shaped area extending from the small cavity; aperture subrhomboidal and projecting partially over the umbilical region at the columella; sculpture of upper surface consisting of closely set spiral striations crossed by extremely fine, obliquely disposed striæ, and forming a minutely reticulated structure, posterior margin of whorls bearing a regular series of small, somewhat obscure, longitudinally elongate nodes; basal surface with a similarly constituted ornamentation but extending only to the circular groove, which is bordered by obscure nodulations.

Dimensions.—

Height	8 mm.
Diameter	12 ,,

Observations.—This small Gastropod is represented by five specimens in different states of preservation which, so far as research has gone, appears to be an entirely new form. It may be distinguished by its obtusely conical shape, the small and partially closed umbilicus circumscribed by a narrow circular furrow, and the finely reticulated surface ornament, which is without the usual granulated sculpture rings of this genus. It is probably related, however, to *Solarium pulchellum* of Baily and *S. wiebeli* of Griesbach, both regarded by Mr. H. Woods as one species under the name of *S. bailyi* of Gabb (*Annals South African Museum*, 1906, vol. 4, part 7, pl. 38, figs. 4, 5, p. 315), from the Campanian rocks of Pondoland. Our species has a nearly similar sculpture, and is chiefly separable on account of the presence of the basal groove which surrounds the

umbilical region. It is not to be confused with Mr. Etheridge's *Solarium sp. indet.* from the Umkwelane Hill deposits of Zululand (Anderson's "Second Report Geol. Surv. Natal and Zululand," 1904, pl. 2, figs. 35–37, p. 88), because of the absence of a median depression in the whorls; nor with that author's more lately described form of *S. hedleyi* from the Umsinene River beds of the same country (Anderson's "Third Report, Geol. Surv. Natal and Zululand," 1907, pl. 5, figs. 10–12, p. 85), which has a sharper and more angulate contour and no indication of the isolated basal groove, being instead ornamented beneath by numerous revolving rows of granules.

The new shell is also distinct from north African Cretaceous species, such as *S. cf. granosum*, Orbigny (see Peron: Desc. Moll. Crétacés, *Explor. Scientif. Tunisie*, 1890, p. 44), which M. Peron has described from the Cenomanian of Tunis, being of less discoidal shape and without a granulate surface; moreover, it seems to share no relationship with any of the European forms found in the various stages of the Cretaceous period, and further, it may be stated, that rocks of similar age in India have yielded no species which would suggest any close affinities with the present shell. The name *Architectonica* of Bolten having priority of Lamarck's *Solarium* is adopted on this occasion, thus following the views of H. and A. Adams (The Genera of Recent Mollusca, 1853, vol. i., p. 241), and later authors.

Locality.—North end of False Bay.

ARCHITECTONICA KOSSMATI, n. sp.

Plate VIII., figs. 11, 12.

Description.—Shell small, elevated, broadly conical, composed of five or six depressed, medianly concave whorls obtusely angulate at margins, and separated by a narrow and well-defined suture; base convex, nearly circular, furnished with a deep funnel-shaped umbilicus bordered by a sub-angulate periphery with a crenulated structure; sculpture of upper surface consisting of numerous, fine, equidistant spiral lines (about 14 on the last volution), crossed by delicate, slightly oblique, and numerous lines of growth (sometimes producing minute granulations), which continue over the margin to the basal surface, where a similar ornamentation exists; the surface of the umbilical cavity is strongly striated both spirally and longitudinally; aperture sub-quadrate.

Dimensions.—

Height	10 mm.
Diameter (maximum)	12 „

Observations.—The foregoing characters are drawn up from an only specimen found in Mr. Anderson's collection, which is in a fair

state of preservation and belongs to the group of the broadly conical forms of this genus of which J. de C. Sowerby's *Solarium conoideum* from the Albian rocks of Britain and Europe may be regarded as a characteristic example, as opposed to more depressed species represented by such a shell as *Solarium ornatum* of J. de C. Sowerby from deposits of similar age. Although built upon the same plan as *S. conoideum,* the shell from Zululand exhibits certain details of structure which are of importance for purposes of separation. The whorls have a less excavated surface and are not so sharply defined at the periphery; the spiral lineations are by no means so numerous, and there is an absence of the rows of transversely elongate granulations which ornament the margins of the whorls both above and below the suture in the European shell; and further, the spiral striæ are much more obvious on the walls of the umbilical cavity, these being seldom present in the *conoideum,* where only longitudinal striations are mostly preserved. Both conical and depressed forms of this genus are referred to by Stoliczka as occurring in the Indian Cretaceous, but none appear to possess the characters of the present shell.

Under the name of *Solarium pulchellum* (subsequently altered by Gabb to *Architectonica bailyi*), Baily figured and described a shell from the Cretaceous cliffs of South-Eastern Africa (= Pondoland) which belongs rather to the depressed and discoidal forms than to those with more elevated spires. His species is, however, considerably smaller than the present specimen, besides having a relatively more restricted umbilicus, whilst the upper surface of the volutions are not described as being excavated. Mr. Etheridge, jun., refers to another form (*Solarium sp. indet.*) from the Umkwelane Hill deposits which in its decussated sculpture is like Baily's species, but showing a median concavity of the whorls (Anderson's "Second Report Geol. Surv. Natal and Zululand," 1904, pl. 2, figs. 35–37, p. 88) such as is present in the shell now described, although differing in its much smaller size and more depressed spire; and further, no umbilical characters are mentioned. The Umsinene River deposits of Zululand have yielded *S. hedleyi,* also described by R. Etheridge, (Anderson's "Third and Final Report Geol. Surv. Natal and Zululand," 1907, pl. 5, figs. 10–12, p. 85), but this differs in being of smaller form and in its very distinct ornamentation of revolving lines of granules interspaced with simple spiral threads. The Albian and Cenomanian rocks of Northern Africa (Algeria, Tunis, &c.) have also yielded various species of *Solarium,* which, however, are easily distinguishable from the present shell either in their contour or details of sculpture.

The specific name is in honour of Dr. Franz Kossmat, the author of some valuable memoirs concerning the correlation of the Cretaceous deposits of India with Africa and other countries.

Locality.—Tributaries of the Manuan Creek.

Family TURRITELLIDÆ.

Genus TURRITELLA, Lamarck, 1799.

Mém. Soc. Hist. Nat. Paris, 1799, p. 74.

Turritella manuanensis, n. sp.

Plate VIII., figs. 16, 17.

Description.—Shell elongate, narrow, many-whorled; volutions moderately deep, slightly convex, distinctly and obliquely sutured; sculpture consisting of five, nearly equidistant spiral rows of regularly spaced granulations with intermediate parallel thread-like striæ occasionally developing into minute tubercles; growth-lines obscure and furnished with a median, curved insinuation; base rounded, convex, spirally striate and granulated.

Dimensions.—

Length (probable)	55 mm.
Diameter (base)	10 „
Height of basal whorl.........................	10 „

Observations.—Only three or four fragments represent this form of *Turritella*, the largest and most perfect measuring 33 mm. in length and possessing the seven last whorls. The basal characters are badly preserved, although parts of a short columella can be seen, whilst the aperture, now fractured, was probably more or less rounded. It is the dorsal view, however, of this specimen which is important as revealing those details of sculpture which appear to separate it from other species. Taking the structure of the penultimate whorl as indicative of all the previous ones, the base is seen to be obliquely bevelled inwards to the suture, its surface bearing eight thread-like spiral striations, above being a ring of tubercles or granulations, then another spirally striate surface succeeded by further tubercles and striated interspaces to the number of five rows of tubercles in all, the two upper being very close to each other and separated by only a pair of thread-like striations. Between the two rows of granulations above the suture the central of the threaded lines develops into minute transversely elongate tubercles. Mr. Etheridge (Anderson's "Third and Final Report Geol. Surv. Natal and Zululand," 1907, pl. 5, figs. 4, 5, p. 84) figures and describes from the Umsinene

River deposits two imperfect fragments of a Turritelloid shell which he refers to *Zaria* (?) *sp.* showing somewhat similarly ornamented whorls but with fewer rows of spiral granulations and apparently less developed, besides having more depressed whorls and a considerably less distinct suture. The new form is also very distinct from Baily's *T. bonei* from the Pondoland territory of South-East Africa (*Quart. Journ. Geol. Soc.*, 1855, vol. xi., pl. 12, fig. 7, p. 458), a species much more deeply sutured and ornamented with elevated spiral ridges which show no evidence of a granulated structure. Stoliczka's *T. nodosa* (Römer) from the Utatur group of Southern India (Cretaceous Gastropoda Southern India: *Pal. Indica,* 1868, pl. 17, fig. 7, pl. 19, figs. 20, 21, p. 222) shows spiral granulations, but the tubercles are much more closely arranged and nearly touching each other, whilst the whorls are more depressed and the suture is not so prominent.

Locality.—Tributaries of the Manuan Creek.

Family APORRHAIIDÆ.

Genus DREPANOCHEILUS, F. B. Meek, 1864.

Check List of the Invertebrate Fossils of North America—Cretaceous and Jurassic, *Smithsonian Miscellaneous Collections* 177 (Washington), 1864, p. 35.

Drepanocheilus, sp.

Plate VIII., fig. 21.

Description.—This specimen is a matriciform impression associated in the same rock with *Inoceramus choffati.* By the aid of a wax squeeze, its relationships to an Aporrhaiform-shell are at once apparent, but unfortunately only the basal whorl is preserved, the elements of the spire being entirely wanting. Viewed from the wax reproduction, the whorl is observed to lie in the dorsal position, exhibiting an oblique narrow and depressed posterior region succeeded by a prominent horizontal peripheral margin from which extends horizontally a long, narrow, lateral spine; the anterior part of the whorl contracts fairly rapidly from the peripheral angulation and is subsequently produced into a straight, narrow canal; the surface sculpture consists of a series of close, equidistant spiral ridges, one of which, situated about 2 mm. below the periphery, is more elevated than the others and therefore forms a second angulation; in the anterior region these striations are crossed by distant obscure radio-longitudinal striæ; the summit of the peripheral margin appears to be obscurely funiculated.

Dimensions (comprising the spinous extensions).—

Length	12 mm.
Width	16 „

Observations.—This relic appears to find its place in the genus *Drepanocheilus* on account of its single lateral spinous projection, which, however, has no spreading character or curvature as in the type, but is quite narrow and horizontal throughout its length. It is difficult to associate it with any described species, although a great deal has been written on this group of Gastropods. It is most probably related to the Albian form of *Rostellaria calcarata* of J. Sowerby, which, according to Starkie Gardner exhibits considerable variation in the width and character of the labial extension *Geol. Mag.*, 1875, pl. v., figs. 7–16, pp. 128–130); in ornamentation it also favours the sculpture details of *Rostellaria americana* of Evans and Shumard from the Senonian of the United States.

Meek's original description of this genus, founded upon *Rostellaria americana* of Evans and Shumard (*Trans. Acad. Sci. St. Louis*, 1857, vol. i., p. 42; figured by Meek, Rept. Invertebrate Cretaceous and Tertiary Fossils of the Upper Missouri Country—*United States Geol. Surv. Territories*, 1876, vol. ix., pl. 32, fig. 8, p. 325) from the Upper Cretaceous Series (Senonian) of Nebraska Territory, United States, mentions its resemblance to "*Aporrhais* but without a posterior canal extending up the spire, and having the lip produced into a single, usually scythe-shaped projection. This type, as well as the including genus *Anchura*, differ from the Jurassic genus *Alaria* in never having the labial appendage developed during the growth of the shell, so as to be left behind the aperture as projecting spines on the body-whorl or spire. It, however, probably includes some of the so-called *Alaria*."

According to M. Cossmann, *Dimorphosoma* of Starkie Gardner (*Geol. Mag.*, 1875, p. 396: type = *Rostellaria calcarata*, J. Sowerby) should be recognised as a synonym of this genus (Essais de Paléoconchologie Comparée, 1904, part 6, p. 75).

Locality.—Tributaries of the Manuan Creek.

Genus PERISSOPTERA, R. Tate, 1867.

Geological and Natural History Repertory (S. J. Mackie), 1867, p. 98.

Perissoptera, sp.

Plate VIII., fig. 20.

Observations.—Among the False Bay material is the earlier portion of an *Aporrhais*-like shell showing about 7 whorls all moderately

convex and of graduating depths which are ornamented with numerous equidistant, longitudinally curved plications separated by fairly wide interspaces, the entire surface being covered with innumerable spiral and longitudinal striæ, thus establishing a minutely decussated structure. The apex of the fossil is obtusely pointed, whilst the three succeeding whorls are well inflated and of comparatively smooth surface.

Dimensions.—

Height	13 mm.
Diameter	7 ,,

Being only a fragment, this specimen retains no indication of the digitate expansion, nor is there any evidence on the side of the spire of the labrum's extension in that direction. It probably belongs to Tate's genus *Perissoptera*, of which Mantell's *Rostellaria parkinsoni* from the Albian of Blackdown, may be regarded as the type, in which "the wing is applied against the last whorl but one, and not extending on the rest of the spire" (Tate, *Geol. Nat. Hist. Repertory*, 1867, p. 98).

This genus extends from Neocomian to Danian times (see Cossmann, Essais de Paléoconchologie, 1894, part 6, p. 95). Although the character of the sculpture of the African shell would favour its relationship with such a form as the Albian species referred to, much better material is required before a more certain determination can be arrived at.

Locality.—North end of False Bay.

Family FUSIDÆ.

Genus SEMIFUSUS, Swainson, emended P. Fischer.

= *Hemifusus*, Swainson.

A Treatise on Malacology, 1840, pp. 91, 308; Manuel de Conchyliologie, 1884, p. 622.

Semifusus, sp.

Plate IX., fig. 6.

Description.—Specimen consisting of a body-whorl in the dorsal position with a wide and gently excavated posterior region, succeeded by a pair of sharply developed carinations 4 mm. apart, then anteriorly rapidly contracting into a funnel-shaped contour and ending with a narrow prolongation. The anterior surface is covered by a series of nearly equidistant spiral lines which enclose finer spiral striations, the whole being crossed by numerous fine, radio-

longitudinal lines; the bicarinate area is slightly concave and bears the same character of ornamentation as the remaining part of the whorl, with the exception that the spiral lines appear to be more numerous and more delicate whilst the longitudinal striations are mostly coarser.

Dimensions (specimen without spire).—

Length	32 mm.
Width	19 ,,

Observations.—This Gastropod is represented by a matrix-cavity associated with *Inoceramus expansus, Baculites* (see p. 96), &c., its characters being drawn up from a wax squeeze. Although only the body-whorl is preserved, and that a dorsal view, it appears to be closely related to *Semifusus ? (Mayeria ?), sp.*, figured by Mr. H. Woods from the Campanian of Pondoland (*Ann. South African Museum*, 1906, vol. 4, pl 40, fig. 5, p. 324), both exhibiting the bicarinate character, a similar surface structure, and a depressed posterior region above the periphery of considerable width.

A similarly related form is also met with in the Ariyalur Cretaceous of Southern India, that is, judging from a specimen described and figured by Stoliczka as *Lagena secans* (Cretaceous Gastropoda, Southern India, *Pal. Indica*, 1867, pl. xi., fig. 20, p. 138). Certain resemblances likewise can be traced with *Semifusus dakotensis* var. *vancouverensis* of Whiteaves, from the Upper Cretaceous of Vancouver and Dakota (Mesozoic Fossils, *Geol. Surv. Canada*, 1879, vol. 1, pl. 15, fig. 5, p. 119; and Meek, Rept. Invert. Cretaceous and Tertiary Fossils, Upper Missouri Country, *United States Geol. Surv. Territories*, 1876, pl. 32, fig. 7*a*, p. 375), although that form is inclined to show a more or less nodose peripheral keel, whereas the specimen from Zululand does not appear to possess these ornaments.

Two further species might well be placed with the genus *Semifusus*, viz., *Fusus albensis*, of Orbigny (Pal. Française, Terr. Crétacés, Gasteropoda, 1842, pl. 222, figs. 8–10, p. 334), and *Fusus (Murex) quadratus*, J. de C. Sowerby (*Trans. Geol. Soc. London*, 1836, Ser. 2, vol. 4, pl. 18, fig. 17, p. 343, and Mineral Conchology, 1823, vol. 5, pl. 410, fig. 1, p. 7), both of which are of Albian age and exhibit the bicarinated character. Notwithstanding these records this genus was not particularly common in Cretaceous times, being probably better known in the Tertiary epoch, one of the most familiar species being Solander's *Strombus errans*, found in the Barton Beds of Hampshire. It is interesting to mention that M. Cossmann has referred to *S. errans* and other forms of *Semifusus* under Bellardi's "*Mayeria*," in his "Essais de Paléoconchologie Comparée," 1901, part 4, p. 93.

Locality.—Umkwelane Hill.

Family RINGICULIDÆ.

Genus AVELLANA, Orbigny, 1842.

Paléontologie Française, Terr. Crétacés, Gasteropoda, 1842, p. 131.

Avellana cf. incrassata, J. Sowerby.

Plate VIII., figs. 6–8.

Auricula incrassata, J. Sowerby, Mineral Conchology, 1817, vol. 2, pl. 163, figs. 1–3, p. 143; Mantell, Geology of Sussex, 1822. pl. 19, figs. 2, 3, 34, p. 110.

Avellana incrassata, Orbigny, Paléontologie Française, Terrains Crétacés, Gasteropoda, 1842, pl. 168, figs. 13–16, p. 133; Jukes-Browne and Hill, Cretaceous Rocks of Britain, Gault, &c., *Mem. Geol. Surv. United Kingdom*, 1900, p. 461.

Observations.—The collection contains a single specimen of *Avellana*, which shows affinities with the *incrassata* of James Sowerby, a characteristic species of Albian deposits although found as well in rocks of Cenomanian age. The specimen is a good deal fractured at the aperture, so that the prominent outer lip is altogether absent, but in most other respects it agrees with the characters as originally defined, viz., "ovate, ventricose, transversely sulcated, longitudinally striated; spire short; mouth angular above, with very thick lips; columella three-plaited." A difference is noticeable in this last character, as only two plaits are recognisable on the present shell—a phenomenon not altogether unusual as an examination of some Blackdown specimens readily shows, because among such are certain forms with two as well as three folds on the columella. The short longitudinal striations between the spiral ridges are well preserved although of microscopical size, being clearly definable with the aid of a good lens and observed to be equidistantly arranged. It appears to differ from *Eriptycha perampla* (= *Avellana ampla*, Griesbach *non* Stoliczka) of Mr. H. Woods from the Cretaceous of Pondoland (*Annals South African Museum*, 1906, vol. 4, part 7, pl. 41, fig. 2, p. 329) by reason of its more elongate form, as well as possessing longer and more developed striations between the spiral ridges. So far as can be ascertained without actual specimens for comparison, the shell from Zululand is different from any of the forms described by Stoliczka as belonging to the Indian Cretaceous series.

Dimensions.—

Height	15 mm.
Diameter (max.)	10 ,,

Locality.—Tributaries of the Manuan Creek.

PELECYPODA.

FAMILY ARCIDÆ.

GENUS CUCULLÆA, Lamarck, 1801.
Syst. Anim. sans Vert., 1801, p. 116.

CUCULLÆA WOODSI, sp. nov.
Plate IV., figs. 4–9.

Description.—Shell sub-quadrate, thick, inflated, slightly inæquilateral; umbonal region elevated, arched, obtusely and obliquely carinated posteriorly with extension to the postero-ventral angle; anterior margin short, rounded and obtusely angled at the hinge; posterior region oblique, deep, vertically sided, obtusely angled at the hinge, and medianly ridged in the young state; ligament-area moderately wide, lanceolate, with from four to five thin, angulate sulcations which deflect outwards from beneath the umbo of each valve; hinge thick, lower margin slightly curved, bearing about eight small central nearly vertical teeth and four or more elongate, oblique teeth on each side; ornamentation consisting of numerous obscure, radial striations, crossed by prominent, rugose concentric lines of growth within which is a finer and closer series of concentric ridges separated by very narrow grooves.

Dimensions.—

	Left Valves. Large.	Left Valves. Medium.	Small specimen with closed valves.
Length	50	42	25 mm.
Height	52	45	25 „
Diameter	30	23	22 „

Observations.—This species shows a relationship to Parkinson's *C. glabra* (Organic Remains, 1811, vol. 3, p. 171) from the Blackdown beds, although certain differences exist which seem to require the separation of the two forms. The valves from Zululand are distinctly more oblique, they are shorter posteriorly, and the length and height are of nearly similar dimensions. A greater convexity is also apparent, so that when both valves are united they present a more or less globular appearance; the dentition differs also in structure, inasmuch as the lateral teeth are inclined to obliquity and not so horizontal or parallel with the hinge margin as generally observed in the English species; and lastly, the shell sculpture appears to be of a coarser design.

It perhaps agrees more nearly with Mr. H. Woods'* interpretation of *Arca obesa*, a species originally described by Pictet and Roux (Moll. Foss. Grés Verts Genève, 1852, pl. 38, figs. 1, 2, p. 464), from the Albian rocks of Switzerland, especially in the deep posterior sides, which contribute to the marked convexity of the valves. The new species may probably be placed between the two forms referred to.

Parts of eight specimens are represented in the collection, being connected with the same matrix as that containing *Trigonia cricki* and some further shells. The rock is of a marly character, of light brown, or fawn colour.

So far as can be ascertained no species of similar characters has been recorded from either Africa or India, if we except Müller's *Cucullæa* cf. *glabra* from the Neocomian of German East Africa (in Bornhardt's "Deutsche-Ost-Afrika," 1900, vol. 7, pl. 25, figs. 1, 2, p. 561), which, however, shows a less pronounced umbonal region, more compressed valves, and differences of sculpture.

The species is named after Mr. Henry Woods, author of a monograph on the Cretaceous fauna of Pondoland, South Africa.

Locality.—Tributaries of the Manuan Creek.

CUCULLÆA, sp.

Plate IX., fig. 5.

Description.—Shell rhomboidal in shape, convex, with a slightly anterior umbo, whilst the dorsal and ventral margins appear to be more or less parallel to each other. The posterior area is depressed besides being very obliquely and sharply angulated within, its outer margin being nearly perpendicular; anteriorly the margin is rounded; both the anterior and posterior borders form sharp angulations at the hinge extremities. The sculpture is most indistinct and is seen only on the lower part of the posterior slope, appearing to consist of fairly strong radial striations equidistantly arranged, crossed within by short, closely placed, oblique lines. Remains of concentric ornamentation are obscurely seen on the otherwise much worn lateral face of this specimen.

Dimensions.—

Length	18 mm.
Height	11 ,,
Diameter	5 ,,

Observations.—The specimen referred to consists of an external view of a badly preserved right valve belonging to a small individual,

* **Woods, H.**—Cretaceous Lamellibranchia of England, *Mon. Pal. Soc.*, 1899, pl. xii., figs. 6–8, p. 61.

in which some obscure testiferous structure can be traced near the postero-ventral angulation. So far as can be observed from such an imperfect specimen, and especially from its form, it seems to be more closely related to *Arca carinata* of James Sowerby and its equivalent *Cucullæa costellata* of J. de C. Sowerby (Mineral Conchology, 1813, vol. 1, pl. 44, lower figures, p. 96; 1824, vol. 5, pl. 447, fig. 2, p. 67), a characteristic shell of Albian age as found in the Blackdown beds of England, than to any other form known to the present writer occurring in later Cretaceous deposits. In this way, also, the specimen is curiously like R. Tate's figure of *Arca* (*Cucullæa*) *jonesi* from the Uitenhage beds (= Neocomian) of South Africa (*Quart. Journ. Geol. Soc.*, 1867, vol. 23, pl. 9, fig. 9, p. 161), and very unlike any further species from the more modern Cretaceous deposits of the same region, such as have been described by Baily, Woods, &c., from Pondoland, and by Etheridge, jun., from Zululand. It is quite impossible to say anything further with regard to Mr. Anderson's specimen, and we can only await further material for its more precise determination.

The specimen is out of the same matrix as contains *Inoceramus expansus*, *Baculites* (see p. 96), &c.

Locality.—Umkwelane Hill.

Genus TRIGONARCA, Conrad, 1862, emended Stoliczka, 1871.

Proc. Acad. Nat. Sci., Philadelphia, 1862, No. 5, p. 289.
Cretaceous Pelecypoda, Southern India, *Palæontologia Indica*, 1871, p. 338.

Trigonarca ligeriensis, Orbigny.

Plate IV., figs. 13–18.

Arca ligeriensis, Orbigny, Pal. Française, Terr. Crétacés Lamellibranchia, 1844, vol. 3, pl. 317, figs. 1–3, p. 227 [not figs 4 and 5, which were afterwards excluded from this species by the same author, in the "Prodrome de Paléontologie," 1850, vol. 2, p. 164, No. 388].

Trigonoarca ligeriensis, Stoliczka, Cretaceous Pelecypoda Southern India, *Pal. Indica*, 1871, p. 338 (reference only; species does not occur in India).

Cucullæa (*Trigonoarca*) *ligeriensis*, Hamlin, Syrian Molluscan Fossils, *Mem. Mus. Comp. Zoology, Harvard College*, 1884, vol. x., No. 3, p. 58.

Cucullæa ligeriensis, Blanckenhorn, Beitrage Geologie Syriens, 1890, p. 81; Dacqué, *Palæontographica*, 1903, vol. 30, part 2, fasc. 5, pl. 35, figs. 11, 12, p. 372.

Observations.—The False Bay deposits have yielded some excellent examples of this form of *Trigonarca*, illustrating three stages of growth. The largest is a right valve with an imperfect postero-ventral end, and adherent to its upper surface and partly covering the carination is the lower valve of an *Exogyra*. It is of very similar size to Orbigny's type specimen figured on plate 317, figs. 1 and 2, and appears to have the same amount of arching, an equally wide posterior area, and a ligamental region of corresponding dimensions. The dentition of this valve is, however, somewhat coarse, whilst the antero-terminal denticles are more horizontal than oblique, as characterise the other specimens with which this is associated. As representing the more normal size of the species are three right valves, the smallest agreeing with fig. 3 of the original plate, the others being of relatively larger proportions. The younger stage of the shell is exemplified in the three remaining valves (two right and one left), which show all the characteristics of the others, but which on account of their much smaller size appear to be somewhat shallow, although in reality their measurements are quite proportionate.

Dimensions (of five single valves).—

	Large.	Medium.	Small.
Length............	(about) 65	50 to 59	30 to 40 mm.
Height............	45	30 to 39	20 to 25 ,,
Diameter.........	25	16 to 20	7 to 10 ,,

These valves, although with occasional fractured margins and with surface structures often replaced by a formation of radial calcite both internally and externally, are singularly well preserved, besides being entirely free from matrix, so that the interiors are properly exposed. The teeth show serrated summits, especially in old forms, and minutely plicated lateral surfaces; the adductor scar markings are well developed, together with the prominently projecting curved lamina, which circumscribes the base of the posterior impression; a series of rather wide, smooth plications, separated by narrow grooves, occur just above the pallial line in radial arrangement, being strongest in the region of the postero-ventral angle. The external sculpture of the valves includes not only the concentric growth-lines, which are periodically more strongly marked than the others, but also a radially striated ornamentation is present, more or less obscure in aged specimens though well defined in youth. This radial sculpture is usually restricted to the end regions of the valves, but in the largest of the present specimens it can be traced over nearly the whole anterior face of the valve. It is in connection with this radial ornament that the present *Trigonarca* differs from the true *ligeriensis*, which is a shell without evidence of radial orna-

mentation—*entierement lisse*—a distinction which would suggest that the present African shell should be regarded under another name. It may be mentioned, however, that French examples of this species in the British Museum from the typical Cenomanian locality of Le Mans, Sarthe, exhibit this radial sculpture, making it possible that the original specimens were badly preserved or had not been sufficiently examined. In all other respects there is a close connection between the present shells from Zululand and the French species, especially when the angularity of the valves is considered together with their great convexity. The dentition of the African valves also agrees in every respect with that figured by Orbigny.

The species has been recorded by Hamlin and Blanckenhorn from Syria, the latter recognising it as of Cenomanian age. Syrian examples consist largely of internal casts, and have been figured by Conrad as *Arca indurata* (Lynch's Official Report United States Expedition, Dead Sea, &c., 1852, pl. 5, fig. 33, p. 216), a species regarded by Blanckenhorn as part of the synonymy of *A. ligeriensis.* Similarly, casts from the Turonian of Egypt have been figured and described by Dr. Edg. Dacqué as resembling fig. 4 of Orbigny's plate 317, which, however, was subsequently (see synonymy) removed from that species by Orbigny himself. Stoliczka has also referred to the French species, not as occurring in India but as a member of the European Cretaceous fauna, this author regarding the shell, probably for the first time in literature, as belonging to Conrad's genus *Trigonarca.**

Mr. H. Woods does not acknowledge the presence of *T. ligeriensis* in British rocks unless it may prove to be identical with *T. passyana* of Orbigny, also a Cenomanian shell, found at English localities, and which is particularly characteristic of the Rouen deposits (Cretaceous Lamellibranchia, England, *Mon. Pal. Soc.*, 1899, p. 47).

Locality.—North end of False Bay.

Trigonarca sp.

Plate IV., figs. 10–12.

Observations.—The specimen here referred to consists of a single left valve, of evidently adult growth, being structurally very robust and thick and much worn. In contour it is elongately triangular, convex, and furnished with an obliquely abrupt, deep, nearly vertical posterior side, besides having a similarly deep, vertical face to the

* Founded in 1862 (*Proc. Acad. Nat. Sci., Philadelphia*, No. v., p. 289) on the type of *Cucullæa maconensis*, Conrad (*Journ. Acad. Nat. Sci., Philadelphia*, 1860, Ser. 2, vol. 4, pl. 47, fig. 20, p. 28). Genus essentially Cretaceous.

ventral region; an obtuse, sloping carina extends from the umbo to the postero-ventral angle; strong concentric periodical growth-lines ornament the lower half of the shell, at the margins of which occur obscure and nearly obsolete radial striations; the surface between the umbo and the first growth-line is comparatively smooth.

Dimensions (left valve).—

Length	50 mm.
Height	32 ,,
Diameter	20 ,,

The worn character of this valve renders its relationships somewhat difficult to understand. It bears, however, some resemblance to *Cucullæa rugosa* of Holzapfel (*Palæontographica*, 1889, vol. 35, pl. 22, fig. 1, p. 208) from the "Aachener Kreide" of Germany, the age of which is recognised as Lower Senonian or Emscherian. The shell possesses a similar straight ventral margin which is nearly parallel with the hinge-line, and from what can be seen of the dentition it seems to agree very closely with this European species. From *T. ligeriensis* it differs in its rather more abrupt and deeper posterior side.

Locality.—Tributaries of the Manuan Creek.

Family GLYCYMERIDÆ.

Genus GLYCYMERIS, Da Costa, 1778.

Historia Naturalis Testaceorum Britanniæ, or, The British Conchology, 1778, p. 168.

Synonyms—*Axinæa*, Poli, 1795, and *Pectunculus*, Lamarck, 1799.

Glycymeris griesbachi, sp. nov.

Plate III., figs. 13–17.

Description.—Shell convex, thick, sub-globose, nearly equilateral, sub-circular, length and height equal; umbones rounded, incurved, almost mesial; central region elevated, lateral areas deep and oblique; anterior and ventral margins rounded, posterior region depressed, sub-angulate, grooved obliquely and medianly from the umbo (in the adult), and terminating with a marginal notch; interior well excavated, round, with denticulated margin; hinge area wide, sub-arcuate, with numerous divergent ligamental furrows, from 4–6 elongate lateral teeth, the centrals being thick and distant; ornamentation exhibiting numerous, small, closely-set, rounded, radial costæ forming equal groups of about six each, divided by lateral ribs of rather more prominence than the others; radial sculpture crossed

by numerous fine concentric striations and the more distant growth-lines.

Dimensions (left valves).—

	Adult.	Medium.
Length	35	25 mm.
Height	35	25 ,,
Diameter	15	9 ,,

Observations.—The distinguishing character of the species is its ornamentation, the valves being covered with extremely fine and close radial costæ of almost microscopical size, although coarser in the adult shell, forming colonies of equal width (less apparent on the lateral regions), each composed of about six costæ, marked off by a pair of lateral ribs slightly more prominent than the others. In contour this shell resembles *Pectunculus sublævis* of J. de C. Sowerby (Mineral Conchology, 1824, vol. 5, pl. 472, fig. 4, p. 112) from the Albian rocks of Blackdown, but in that species the radial costæ are much wider, fewer, and of one order only, without any attempt at a zonal arrangement.

In a similar way the present species differs from Forbes's *P. subauriculatus*, from the Southern Indian (Pondicherry) Cretaceous (*Trans. Geol. Soc., London*, 1846, Ser. 2, vol. 7, pl. 17, fig. 13), a species which Mr. Griesbach regarded as being related to his Natal species *P. africanus* (*Quart. Journ. Geol. Soc.*, 1871, vol. 27, pl. 3, fig. 8, p. 66), described as possessing a " finely and radiately striated surface."

Stoliczka's (Cretaceous Pelecypoda Southern India, *Pal. Indica*, 1871, pl. 17, figs. 31, 32, p. 349) conception of Forbes' species is very unlike the type in general outline, but, strange to say, it agrees perfectly well with the contour of the present species, especially the younger valves, although the absence of any mention in the description of a zonal ornamentation is insufficient evidence for bracketing the African shell with the Indian form.

Three of the medium-sized specimens (Manuan Creek district) are in a light-coloured limestone, the only right valve exhibiting some details of the hinge area. Another example (False Bay) of similar dimensions is of reddish-brown colour and quite isolated from the matrix; it shows internal features but has a much eroded outer surface which obscures the ornamentation. The largest or adult valve (False Bay) is also isolated and of similar colour to the last referred to. It has a considerably fractured margin and a broken umbo, but in other respects the characters are well seen. The radial costæ, on account of age, are somewhat coarser than in the smaller valves, and the posterior side is accentuated by an obliquely median furrow

extending from the umbonal region and terminating in a marginal notch. Internally the valve is seen to be well excavated; it presents a wide and sub-arcuate hinge region with the divergent ligamental furrows, whilst some of the lateral and central teeth are well preserved; the marginal denticulations are also seen in places.

Named after the late C. L. Griesbach, Esq., formerly Director of the Geological Survey of India, and author of an important memoir (*Quart. Journ. Geol. Soc.* for 1871) on the geology and palæontology of the south-eastern territory of Africa, known in the present day as Pondoland.

Locality.—Tributaries of the Manuan Creek, and north end of False Bay (=the figured examples).

Family TRIGONIIDÆ.

Genus TRIGONIA, Bruguière, 1789.

Encyclopédie Méthodique [Paris], 1789, vol. i., p. xiv.

Trigonia cricki, sp. nov.

Plate V., figs. 10–15.

Description.—Shell of crescentic form with moderately inflated sides, surface depressed at front end; postero-marginal area deeply concave, smooth, rounded, medianly furrowed, tapering from the umbo to a basal width of 10 mm. in the larger specimen and covered with fine and closely arranged concentric striations; escutcheon wide, concave, lengthy, rounded beneath the umbones, inner margins raised, surface showing obscure transverse costellæ; valves ornamented with prominent, elevated, rounded, oblique costæ, composed of regular smooth ring-like contiguous segments which are largest anteriorly, the costæ gradually diminishing to a thin attenuated end and joining the posterior margin in an upward oblique direction; costæ divided by wide and deep grooves bearing growth striations; umbo incurved, of moderate inflation and furnished with several rounded costæ (ten can be counted in a distance of 10 mm. from the apex).

Dimensions.—

Specimen with closed valves—

Maximum diameter	27 mm.
Width of escutcheon area	15 ,,

Left valve of the largest specimen—

Width (maximum)	23 ,,
Height from umbonal region to postero-ventral end	43 ,,

Observations.—The material on which this new species is based includes two specimens with united and closed valves exhibiting most of the umbonal half of the shell, but considerably wanting in the ventral region: these occur in the soft reddish-brown marly matrix of the Manuan Creek district. Another, and the largest example, represents a left valve attached by its internal surface to the usual brownish-grey limestone rock of the same region; it is imperfect antero-ventrally and the umbonal area is missing, otherwise the principal costæ are well exposed. Beside these are two further fragments of a right and left valve showing costal and umbonal characters, of similar lithological appearance and which were obtained from the same locality.

This *Trigonia* belongs to Agassiz's group of the Scabræ,* which includes Parkinson's *aliformis* ("Organic Remains," 1811, vol. 3, pl. 12, fig. 9, p. 176), to which it is apparently closely related. It differs chiefly in the character of the costæ, which are more numerous, especially on the umbonal area, as well as being of less delicate structure, being formed of coarser and wider annulations; the dividing furrows are not so deeply sculptured, giving a less elevation to the costæ. Through imperfect preservation none of the finer ribs which should follow the earlier and stouter costæ can be seen; these in the true *aliformis* form numerous, equidistant, almost perpendicular ridges parallel to each other.

Again, the African shell shows a more depressed surface at the anterior end or junction line of the valves, and there is little or no evidence of the marked depression which extends from the umbonal area down the posterior face of the valve to the postero-ventral region, as may be observed in all examples of the true *aliformis*.

The new species, moreover, need not be confused with *T. tuberculifera* of Stoliczka (Mem. Geol. Surv. India, *Pal. Indica*, 1871, pl. 15, figs. 10–12, p. 315), from the Trichinopoly group of Southern India—a form which is of more quadrate contour, being considerably less excavated at the posterior margin, and possessing longer and narrower costæ made up of segments of nearly one uniform size. In similar details the species from Zululand may be said to differ from *T. ventricosa* of Krauss, a species characterising the Lower Cretaceous (Neocomian) deposits of the Uitenhage district of South Africa (*Nova Act. Acad. Cæs. Leop.-Car.*, 1847, vol. 22, pl. 49, fig. 2, p. 456), which besides is of less anterior eleva-

* **Agassiz, L.**—Mémoire sur les Trigonies. Études Critiques sur les Mollusques Fossiles [Neuchatel], 1840, p. 56.

tion and consequently not nearly so wide across the front end region of the valves.

The species is named in honour of Mr. Geo. C. Crick, of the British Museum, and author of a monograph on Cretaceous Cephalopoda from Zululand, published in Mr. Anderson's "Third and Final Report."

Locality.—Tributaries of the Manuan Creek.

Trigonia blanckenhorni, sp. nov.

Plate V., figs. 1–4.

Description.—Shell (right valve) obliquely oviform, thick, elongate, shallow; umbo depressed, incurved; surface unequally divided externally by a rounded carination extending obliquely from the umbo to the postero-ventral margin, anterior or pallial section, the largest being about double the width of the posterior and furnished with from 16 to 18 oblique, smooth, rounded, equally disposed, well-elevated costæ, which proceed from the carina to within a short distance of the outer margin, where they curve upwards by tapering terminations and become merged in the growth lamellæ of the shell, correspondingly deep and smooth sulcations separating the costæ; anterior margin abrupt, deep, smooth, lamelliform, antero-ventral and ventral borders curved; posterior region elongate, depressed, oblique, obscurely furrowed medianly and longitudinally, bearing a narrow, steep, elongate escutcheon area which is bordered by a secondary carina and outwardly by a thickened margin parallel with it; surface ornamentation consists of coarse oblique growth-lines with an upward curvature; interior exhibiting two strong, divergent, transversely striated teeth, the anterior being thick, short, and feebly curved outwards, the posterior unusually elongate and narrow, deep adductor and pedal scar impressions, and a pallial line remotely distant from the ventral border.

Dimensions (a right valve).—

Length	60 mm.
Height	55 ,,
Diameter	18 ,,

Observations.—This *Trigonia* is represented by three right valves, which, although fragmentary, possess some interesting features which appear to separate it from other forms of the genus. It is of unusually smooth sculpture, there being no evidence of any kind of radial striations; the pallial costæ and sulcations are clearly and regularly developed, and show only a very slight curvature in their progress to the anterior border; the smooth posterior region is also

well marked, as also is the elongate insignificant escutcheon which is of such narrow dimensions (= about ½ a millimetre). The valves are exceedingly robust and thick, with a wide arching and consequently of rather shallow capacity, whilst their general facies would allow of a comparison with a form like *Trigonia carinata* of Agassiz which has been recorded from Lower Cretaceous (Neocomian to Aptian) rocks of Britain, Switzerland, &c.

Agassiz's shell is, however, of much greater convexity, its sculpture on the posterior region is much more complicated, including a system of radial ornamentation, whilst the escutcheon area is wider and more cordiform; the pallial costæ are angulate and thin, less curved, more oblique, extending right up to the outer anterior margin in a series of nearly horizontal lines produced by an obtuse angulation occurring about 10 mm. from the border; in the ventral direction the costæ are also sometimes broken and irregular.

Several species of *Trigonia* have been recorded from the Cretaceous rocks of India and Africa, but so far as present inquiries have gone none exhibit the details of the shell from Zululand, although mention may be made of *T. tatei* of Holub * and Neumayr (= *T. cassiope* of Tate *non* Orbigny), described and figured from the Uitenhage deposits of South Africa which belongs to Agassiz's group of the "Costatæ." The Uitenhage shell is, nevertheless, more quadrate in contour, the pallial costæ are more deeply curved and less obliquely disposed, whilst the posterior region bears a well-ornamented series of radial ribs. The costate Trigoniæ, which belong more particularly to Jurassic rocks, are invariably furnished with a highly decorative posterior surface, but in the present shell a strongly costate anterior region is observed in association with a smooth posterior surface. It is among the groups Scaphoideæ and Clavellatæ that the smooth posterior surfaces are to be found, but then they are accompanied by variously arranged nodulations which ornament the anterior division of the valves.

Such facts as these seem to suggest that the shell from Zululand may represent an intermediate form coming between the "Clavellatæ" and "Costatæ."

I have much pleasure in naming this shell after Dr. Blanckenhorn, who has done some important work on the Cretaceous palæontology of Syria and Egypt.

Locality.—North end of False Bay.

* *Denkschrift. K. Akad. Wiss.*, 1882, vol. 44, pl. 2, fig. 3, p. 275.

TRIGONIA cf. SCABRA, Lamarck.

Plate V., figs. 5–9.

Trigonia, Bruguière, Encyclop. Mèth., 1797, pl. 237, fig. 1.

Trigonia scabra, Lamarck, Hist. Nat. Anim. sans Vert., 1819, vol. 6, part 1, p. 63; Brongniart, Desc. Géol. Env. Paris, 3rd ed., 1822, pl. 9, fig. 5, p. 97; Deshayes, Desc. Coq. Caract. Terrains, 1831, pl. 13, figs. 4, 5, p. 35.

Liriodon scaber, Bronn, Lethæa Geognostica, Versteinerungen, 1838, vol. 2, pl. 32, fig. 13, p. 702.

Trigonia scabra, Agassiz, Études Crit. Moll. Foss. Mém. sur les Trigonies, 1840, pl. 10, figs. 1–5, p. 28; Orbigny, Pal. Française, Terr. Crétacés, Lamellibranchia, 1844, pl. 296, p. 153; Coquand, Géologie Paléont. Constantine, 1862, p. 299; Zittel, *Denkschr. K. Akad. Wiss.*, 1864, vol. 24, pl. 9, fig. 2, p. 161; Stoliczka, Crét. Pelecypoda, Southern India, *Pal. Indica*, 1871, pl. 15, figs. 24–26, pl. 16, figs. 35–40, p. 314; Seguenza, *Atti R. Accad. Lincei* (Roma), 1882, p. 154.

Description.—The specimens referred to as related to this species are of medium size, consisting of two right valves and a left one belonging to different individuals. The right valves exhibit some interesting structural characters which may be thus referred to. The anterior or pallial surface is covered with about 26 well-elevated, sub-angulate costæ, the summits of which are covered with obtusely spinulose tuberculations, the interspaces and lateral surfaces of the costæ being ornamented with fine striations. The costæ are obliquely disposed, equally divided at their terminations but widest anteriorly; the posterior region is well excavated, margined in front by a fine carination, succeeding which occurs a depressed medianly sulcated area with its upper part decorated with minutely tubercled, closely arranged, short, oblique plications, the surface afterwards becoming smooth to the postero-ventral angle; a lanceolate escutcheon follows the area, coarsely tubercled and obscurely striated transversely.

Dimensions (right valve).—

Length	32 mm.
Height	30 ,,
Diameter	11 ,,

Observations.—This *Trigonia* is closely related both to *T. scabra* and *T. aliformis* of Parkinson, and chiefly seems to differ from the latter in its more delicate costal structure and in the costæ exhibiting a spinulose ornamentation rather than a funiculate and annulate character. The pallial costæ also are of one distinct order throughout,

whereas in *aliformis* the front portion of the anterior region possesses the thicker and more distant costæ, a series of closer and much thinner costæ occupying the remaining surface to the postero-ventral angle. A fragmentary left valve is also referred to this form, showing considerably worn pallial costæ, a well-ornamented escutcheon surface bearing delicately transverse granulated costellæ of great regularity, and an umbonal convexity, which is more accentuated than in the right valves just described. Although this *Trigonia* appears to have a close association with *T. scabra* it must be remarked that its contour is rather more rostrated posteriorly than is the usual form of that species; it, however, belongs to Agassiz's group of the Scabræ, of which *T. aliformis* may be regarded as the type, its horizon being probably recognised as Cenomanian or Albian; the true *scabra* being characteristic of Cenomanian times, whilst the *aliformis* belongs more particularly to the Albian stage of the Cretaceous series. The Indian examples of *T. scabra* figured by Stoliczka are said to be found in the Trichinopoly and Ariaylur Cretaceous groups.

Locality.—North end of False Bay.

Family MYTILIDÆ.

Genus LITHOPHAGA, Bolten, 1798.

Museum Boltenianum [Hamburg], 1798, Part 2, p. 156.

Synonym—*Lithodomus*, Cuvier, 1817.

Lithophaga manuanensis sp. nov.

Plate IV., figs. 1–3.

Description.—Shell elongate, sub-cylindrical, convex; anterior end rounded, posterior cuneiform, dorsal line slightly curved; latero-ventral areas compressed; umbones moderately inflated, incurved, nearly marginal; ornamentation consisting of rugose, rather distant, concentric growth-lines.

Dimensions (specimen with closed valves).—

Length	30 mm.
Height	13 ,,
Diameter	14 ,,

Observations.—This description applies to a single specimen with closed valves having a considerably fractured test, yet preserving certain elements of structure which are of importance in respect of its determination. The specimen is somewhat longer than the generality of Cretaceous forms of this genus, and the valves show a

rather unusual compression at the sides, as well as a pronounced medio-longitudinal inflation. The sculpture lines are purely concentric, no radial ornamentation being visible. The specimen may be compared with *Lithodomus sub-cylindricus* of Stoliczka (Cretaceous Pelecypoda, Southern India, *Pal. Indica*, 1871, pl. 23, figs. 18–19, p. 376), from the Utatur beds of Southern India, although differing in possessing a slight curvature at the dorsal margin and in having a latero-ventral compression, besides being of greater length. The concentric lineation also is perhaps less regular than in the Indian shell. Again, the species need not be mistaken for the European Cenomanian form, *Lithodomus rugosus*, Orbigny (Pal. Française, Terr. Crétacés Lamellibranchia, 1843, pl. 346, figs. 1–3, p. 294), which is of greater length, more cylindrical, and differing in sculpture by the addition of radial striations on the antero-ventral region.

Locality.—Tributaries of the Manuan Creek.

Family AVICULIDÆ.

Genus PINNA, Linnæus.

Systema Naturæ, 1758, edition X., p. 707.

Pinna cf. complanata, Stoliczka.

Plate IX., figs. 3 and 4.

Pinna complanata, Stoliczka, Cretaceous Pelecypoda, Southern India, *Pal. Indica*, 1871, pl. 24, figs. 3, 4, p. 384.

Observations.—This is a form closely related, if not identical with, *P. complanata*, as described and figured by Stoliczka from the Trichinopoly group of India. Parts of the nacreous layer of the specimen are still preserved, otherwise there is very little of the original shell structure intact, the fossil being more or less in the nature of a cast. On the dorsal region are a few shallow, longitudinal sulcations radiating from the apical region of the shell, and which are, therefore, not quite parallel with the hinge margin; they are quite smooth and show no transverse lineations, which characterise some species, resembling in this manner what obtains in the form from India.

In general contour and size there is also a similarity of design with Stoliczka's species. The dorsal and ventral lines diverge at much the same angle, the valves are elongately trigonal, the dorsal margin being perfectly straight and the ventral having an inward central curvature.

As so frequently happens with this genus, and especially fossil forms, the valves show a median longitudinal fracture or fissure,

which appears to terminate on the posterior margin in a kind of notch or opening, and such a feature is plainly seen in Stoliczka's figure. There is, however, a difference between the Indian and African shells which should be mentioned, and that is in connection with the convexity of the valves. Unfortunately Stoliczka gives no measurements of his species, but states that the valves are very compressed or gently convex—"*valvis aut compressiusculis aut lente convexis.*" The African fossil is, however, well arched in the centre, although rather compressed at the sides, so that the valves would be accurately regarded as fairly convex; the outline figure given of the posterior end will help to explain this point so far as the African shell is concerned, but unfortunately there is no corresponding figure in Stoliczka's memoir to confirm this part of his original description.

Dimensions.—

Length..	145 mm.
Height..	80 „
Diameter.....................................	52 „

The matrix is a heavy dark grey limestone, showing minute black chloritic grains, and containing a fragmentary example of a small *Baculites* (see p. 96), and being therefore lithologically and palæontologically exactly similar to the rock, with the deep cavity representing a specimen of *Inoceramus expansus* of Baily, to be subsequently referred to.

Locality.—Umkwelane Hill.

Genus INOCERAMUS, J. Parkinson, 1819.

Trans. Geological Society [London], 1819, vol. 5, part 1, p. 55, pl. 1, fig. 3.

Inoceramus choffati, sp. nov.

Plate III., figs. 11, 12.

Description.—Shell sub-quadrate, small, antero-medianly arched from umbo; anterior side long, nearly vertical, deep; posterior surface sloping gradually to the margin; hinge margin horizontal, elongate; umbo anterior, short, small, incurved; ornamentation consisting of a regular series of depressed, concentric ridges, separated by smooth shallow sulcations, which widen gradually in the ventral direction; ventral margin rounded.

Dimensions (right valve).—

Length	35 mm.
Height	35 „
Diameter	9 „

Observations.—This specimen is represented by a convex natural cast of a right valve embedded in matrix showing external features, but which is marginally imperfect so far as the posterior and part of the ventral regions are concerned. In general aspect it shows a wonderful resemblance to a small flint example in the Sowerby collection at the British Museum, determined as *I. brongniarti*, of Mantell, 1822—a species which may undoubtedly be included in Parkinson's *lamarcki* of an earlier date. With only one specimen for comparison, and that somewhat imperfect, it would perhaps be premature to consider the Zululand shell as synchronous with the British species, although possessing an exactly similar horizontal hinge-line, a steep and nearly perpendicular anterior side, and with the same character of curvature in the details of the concentric sculpture, with the exception that intermediate striations are not apparently present.

Further, certain similarities can be traced with Mr. Etheridge's *Melina andersoni* from the Cretaceous rocks of Umkwelane Hill (W. Anderson, "Second Rept. Geol. Surv. Natal and Zululand," 1904, pl. 2, figs. 7–10, p. 73), but such differences as an excavation in front of the umbo with a subsequent rounding of the anterior margin, appear to be of sufficient importance for the separation of that species from the present form. Much the same characters would also distinguish it from *Inoceramus volvuimbonatus* of R. Etheridge, from the Cretaceous beds of the Umsinene River (W. Anderson, "Third and Final Rept. Geol. Surv. Natal and Zululand," 1907, pl. 2, figs. 1–6, p. 73), a species which is of greater height than length, and furnished with high and prominent umbones.

It may be also mentioned that the present shell can be distinguished from *I. expansus* of Baily from the Cretaceous of Pondoland (near Umtamvuna River) by its much smaller size and relatively more convex valve, and the absence of concentric striæ on the surface of the sulcations (*Quart. Journ. Geol. Soc.*, 1855, vol. xi., pl. 13, fig. 5, p. 462, and H. Woods, *Annals South African Museum*, 1906, vol. 4, part 7, p. 299).

This fossil is associated in the same matrix with the body-whorl of *Drepanocheilus sp.* and a *Serpula*-tube.

I have ventured to associate with this shell the name of M. Paul Choffat, in recognition of his important researches on the Cretaceous palæontology of various parts of Portuguese Africa.

Locality.—Tributaries of the Manuan Creek.

INOCERAMUS EXPANSUS, W. H. Baily.

Plate IX., figs. 1, 2.

Inoceramus expansus, W. H. Baily, *Quart. Journ. Geol. Soc.*, 1855, vol. xi., pl. 13, fig. 5, p. 462; C. L. Griesbach, *Quart. Journ. Geol. Soc.*, 1871, vol. 27, p. 62; H. Woods, *Annals S. African Museum*, 1906, vol. iv., part 7, p. 299.

Observations.—The original description of this species states that the shell is "ovate, oblique, rather depressed, sub-æquivalve, with concentrically prominent plications, hinge-margin elongated."

Mr. Anderson's specimen is represented by a natural concavity in the matrix, which exhibits the internal impression of what was probably a right valve showing a marginal extension in both directions of 120 mm. (=4¾ inches), and a depth through of about 38 mm. As the margins are very incomplete more accurate dimensions are most uncertain. The sculpture markings consist of a series of distant, elevated, concentric plications with rounded summits, which are separated by wide, well-excavated furrows, bearing obscure concentric striations; remains of the nacreous lining of the valve are still partially preserved.

According to Captain R. J. Garden, who collected the fossils described by W. H. Baily, this shell is of abundant occurrence in the Umtamvuna River district of South Africa, and sometimes attains a considerable size, as he had seen examples of from 2 to 3 feet in length (*Quart. Journ. Geol. Soc.*, 1855, vol. xi., p. 453). The British Museum has a specimen almost a foot from the umbo to the ventral region, but being fractured in that part, it is possible that, under more perfect conditions, it might have extended much further in that direction. Some of the convex natural casts of this species in the same museum have their surfaces studded with numerous rounded pittings from 1 to nearly 3 mm. in diameter, which must have resulted from the presence of corresponding prominences on the inner surface of the valves, and which were most probably of the nature of pearls on account of the nacreous character of the genus *Inoceramus*. Such a structure is well displayed on a figure published by Goldfuss (Petrefacta Germaniæ, 1836, vol. 2, pl. 112, fig. 4*d*, p. 116) of a specimen from the Senonian of Westphalia regarded as *Inoceramus cripsi*—a determination which was subsequently altered to *I. goldfussianus* by Orbigny (Paléontologie Française Terr. Crétacés Lamellibranchia, 1845, pl. 411, p. 517) on account of the shell differing from one previously described by Mantell under the same name from British Cenomanian (=grey chalk marl) rocks (Geology of Sussex, 1822, pl. 27, fig. 11, p. 133).

Natural casts of Baily's *expansus* also frequently show obscure, elevated, radial striations proceeding from the umbonal area to the ventral margin, clearly proving the presence of corresponding markings on the inner surface of the valve.

Associated with this specimen in the same rock are *Cucullæa sp.*, *Semifusus sp.*, and fragmentary *Baculites* (see p. 96), which closely resemble *B. bailyi* of Mr. H. Woods from the Campanian rocks of Pondoland (*Ann. South African Museum*, 1906, vol. 4, part 7, pl. 44, fig. 5, p. 341, which includes *B. sulcatus* (*pars*) of Baily, *Quart. Journ. Geol. Soc.*, 1855, vol. xi., pl. xi., figs. 5*a* and 5*b*, *non* 5*c*, p. 457).

Locality.—Umkwelane Hill.

Genus GERVILLIA, Defrance, 1820.

Dictionnaire des Sciences Naturelles, 1820, vol. 18, p. 502.

Gervillia sublanceolata, Orbigny.

Plate III., figs. 7–10.

Gervillia aviculoides, J. de C. Sowerby, Mineral Conchology, 1826, vol. 6, pl. 511, figs. 1, 2, 3, 5 (*non* 4), p. 16 (*non Perna aviculoides*, J. Sowerby, 1814).

Avicula lanceolata, E. Forbes, *Quart. Journ. Geol. Soc.*, 1845, vol. 1, pl. 3, fig. 8, p. 247 (*non* J. de C. Sowerby, 1826).

Avicula sublanceolata, Orbigny, Prodrome Paléontologie, 1850, vol. 2, p. 119.

Gervillia alpina, Pictet and Roux, Desc. Moll. Foss. Grès Verts Genève, 1853, pl. 41, fig. 3, p. 496.

Gervillia anceps, Pictet and Renevier, Desc. Foss. Terr. Aptien St. Croix—*Mat. Pal. Suisse*, 1858, Ser. 1, pl. 17, p. 121 (*non* Deshayes, 1842).

Gervillia alpina, Pictet and Roux, Desc. Foss. Terr. Crétacé St. Croix—*Mat. Pal. Suisse*, 1869, ser. 5, pl. 155, figs. 2–4, p. 83.

Gervillia sublanceolata, H. Woods, Cretaceous Lamellibranchia of England, *Mon. Pal. Soc.*, 1905, pl. 10, figs. 14–16, pl. 11, fig. 1. Text figures 7, 8, p. 74.

Observations.—The species here determined is represented by four excellent fragments, three of which probably belonged to an individual with a possible antero-posterior measurement of about 170 millimetres. Parts of both valves exhibit details of the hinge region : the oblong ligament cavities being more or less equidistant, and of narrower contour anteriorly, whilst lying beneath these is a pair of elongate, well-elevated, ridge-like teeth, diverging slightly from the anterior extremity and continuing in a posterior direction almost

parallel to each other until they unite in a gentle upward curvature to form the inner margin of the flat dental plate extending from the base of the ligament region. The interior of one of the fragments also shows obscure evidence of a third dental ridge produced by a bifurcation, about half-way, of the lowest ridge and parallel to it; grooves of corresponding length accompany the ridges on each side, the central one being the deepest and most prominent. In more perfect specimens further dental ridges should be seen at the posterior angle, but as only about five ligament pits are present instead of probably double that number it follows that only little more than half the maximum length of the hinge-plate is preserved. Unfortunately the umbones also are not present, so that it is impossible to say how far the valves extended anteriorly, but from comparison with other specimens that extension would have been extremely small. As with most forms of this genus, the left valve shows the greatest convexity, the other being appreciably compressed. The anterior parts of the valves exhibit externally a sub-cylindrical contour with a deep, abrupt, and gently concave ventral region, whilst the dorsal surface is compressed, oblique, and triangulate, thus entering into the formation of the posterior expansion. One of the fragments represents the central region of a left valve, showing its median convexity and well-sloping sides, the ventral margin being well rounded, and the opposite margin being either straight or slightly concave. The outer surfaces of the specimens are furnished with somewhat coarse, oval growth-lines, which agree in every way with the normal ornamentation of this species.

Such characters as are here notified are generally to be met with in good specimens of the species from either Blackdown or Atherfield, and it does not seem possible to refer the remains from Zululand to any other form. To Mr. H. Woods we are indebted for the latest account of this mollusc, its comparison with allied forms being ably worked out by that author.

The late Dr. Stoliczka, who had seen no Cretaceous form of *Gervillia* from Southern India, refers to the fact that Orbigny had described and figured *G. solenoides* of Defrance as occurring in the rocks of Pondicherry (Cretaceous Pelecypoda, Southern India, *Pal. Indica*, 1871, pl. 50, fig. 5, p. 409).

With regard to African examples of Cretaceous *Gervilliæ*, there is only one which need be compared to the present shell, and that is *G. dentata* of Krauss (*Nov. Act. Acad. Cæs. Leop.-Carol. Nat. Curiosorum*, 1850, vol. 22, part 2, pl. 50, fig. 1, p. 458), from the Uitenhage deposits (Lower Cretaceous) of South Africa, a shell,

however, of greater thickness, more robust, and exhibiting a rounded margin in the antero-ventral region instead of a slight concavity; in addition the valves are more convex. *G. dentata* has been recognised by Dr. G. Müller in the Neocomian beds of East Africa (Bornhardt, "Deutsch.-Ost-Afrika," 1900, vol. 7, pl. 24, figs. 8, 9, p. 548), and a further specimen of doubtful determination has been described by Mr. R. Etheridge from the Umsinene River deposits of Zululand (Anderson, "Third and Final Report Geol. Surv. Natal and Zululand," 1907, pl. 1, figs. 13–15, p. 73), which, moreover, is badly preserved and difficult to recognise from the illustrations; the author in this case speaks of its general resemblance to *G. aviculoides* of J. de C. Sowerby and *G. anceps* of Orbigny.

It is interesting to note that so far as can be ascertained, these elongate forms of *Gervillia* are quite unknown in the Cretaceous beds of Northern Africa.

G. sublanceolata appears to range geologically from the Barremian to the Albian (*Schloenbachia rostrata* zone), and is more characteristic of British than foreign localities.

Locality.—North end of False Bay.

Family OSTREIDÆ.

Genus OSTREA, Linnæus, 1758.

Systema Naturæ, 1758, edition x., p. 696.

Ostrea zululandiæ, sp. nov.

Plate II., figs. 1–5.

Description.—Shell of small size with elongate, narrow and moderately shallow valves, the lower being of crescentic shape. The ligamental region is curved and acuminate, whilst the inner margins of the dorsal half of the valves are usually dentated; the anterior border of the lower valve is deep, abrupt and concave, and its surface is marked by concentric growth-lines which are crossed by a few obscure, distant and radial plications. The upper valve has a squarish outline at its commencement, besides possessing a fringed or dentated border.

Dimensions (of two lower valves).—

	Large form.	Small form.
Length	34	20 mm.
Height	15	14 ,,

Observations.—This oyster is of abundant occurrence in the rocks of this region, although mostly in a fragmentary condition. The lower valves are those more frequently preserved, the upper being

extremely rare and incomplete. It appears to be related to Nilsson's *Ostrea curvirostris* from the Campanian deposits of Sweden, having a very similar contour, as well as an acuminate and curved cardinal area, and an upper valve exhibiting a more or less quadrate outline. The obscure plications just traceable on the best preserved lower valve do not, however, appear to be present on specimens from Sweden, that is judging from figures and descriptions as originally published (Petrificata Suecana Cretaceæ, 1827, pl. 6, fig. 5, p. 30), or from the subsequent account of the same species as presented by Coquand (Monographie du genre Ostrea, 1869, pl. 35, figs. 16–22, p. 67). A small Albian *Ostrea* of very similar shape and with a decidedly plicated lower valve, has been collected in large numbers at either Haldon or Blackdown (exact locality not certain) in Devonshire, which are to be seen in the W. Vicary collection at the British Museum, but they have not yet been properly studied, and still await specific determination; all that can be said is that they show as much relationship to *O. curvirostris* as do the present valves from Zululand, but again the plicated lower valve furnishes the distinction. Finally it may be mentioned that in this last character and in its general shape the valves both from Zululand and the Devonshire region show a curious resemblance to the *O. flabellula* of Lamarck from the Lower Tertiaries of England, Europe, &c. There is always great difficulty in determining so variable a shell as an *Ostrea*, and unless preservation is good and both valves are found in contiguity it is of little service for palæontological purposes. We are dealing in the present case with only isolated valves of mostly narrow and elongate form, but there are evidences of other valves showing a more quadrate outline which may represent a further species, but again these are too doubtful and much too fragmentary for accurate description. It is sufficient, therefore, to say that the specimens, now figured and described as a new species, show certain resemblances to *O. curvirostris* of Nilsson, and that they further appear to be characteristic of the rocks of the Manuan River district.

Locality.—Tributaries of the Manuan Creek.

Genus EXOGYRA, T. Say, 1820.

American Journal Science (B. Silliman), 1820, vol. 2, p. 43.

Exogyra conica, J. Sowerby.

Plate II., figs. 8–10.

Chama recurvata, J. Sowerby, Mineral Conchology, 1813, vol. 1, pl. 26, fig. 2, p. 69.

Chama conica, J. Sowerby, Mineral Conchology, 1813, vol. 1, pl. 26, fig. 3, pp. 69, 70.

Chama plicata, ibid., pl. 26, fig. 4, p. 70.

Exogyra conica, J. de C. Sowerby, Mineral Conchology, 1829, vol. 6, pl. 605, figs. 1–3, p. 219.

Exogyra lævigata, J. de C. Sowerby, Mineral Conchology, 1829, vol. 6, pl. 605, fig. 4, p. 220.

Exogyra conica, Goldfuss, Petrefacta Germaniæ, 1833, vol. 2, pl. 87, fig. 1, p. 36.

Ostrea conica, Orbigny, Pal. Française, Terr. Crétacés, Lamellibranchia, 1846, pl. 478, figs. 5–8, pl. 479, figs. 1–3, p. 726; Coquand, Géologie et Paléontologie Constantine, 1862, p. 293; Coquand, Monographie du Genre Ostrea Terrain Crétacé, 1869, pl. 53, figs. 1–7, p. 150; Cotteau, Peron and Gauthier, Echinides Fossiles de l'Algérie, 1878, Fasc. 4, Cenomanian, pp. 18–57.

Exogyra conica, Sequenza, *Atti R. Accad. Lincei* (Roma), 1882, Ser. 3, *Mem.* vol. 12, p. 176.

Ostrea conica, Peron, Desc. Mollusques Crétacés, *Explor. Scientif. Tunisie*, 1891, part 2, pl. 23, figs. 8–10, p. 113.

Exogyra conica, Jukes-Browne and Hill, Cretaceous Rocks of Britain, Gault, &c., *Mem. Geol. Surv. United Kingdom*, 1900, vol. i., p. 466; Cretaceous Rocks of Britain, Upper Chalk, *Mem. Geol. Surv. United Kingdom*, 1904, vol. 3, p. 475.

Observations.—The specimens from the Manuan Creek district referred to this somewhat variable species, consist of five lower valves of small size associated with matrix exhibiting external features, and showing the typically arched form of the shell, with its high, curved, sub-angulate elevation. The posterior side is deep, abrupt, and more or less vertical, or gently sloping outwards, whereas the front area is excavated, depressed, and oblique. The surface is ornamented with irregularly arranged concentric growth-lines, and without any vestige of radial striations covering the umbonal region, such as are described and figured by Orbigny. This radial sculpture is not noticed in the original description, so that it was apparently unknown to the two Sowerbys, whose types were procured from the Blackdown beds, although indications of its presence may be sometimes seen in examples from the same deposits. Prof. Peron was unable to detect such a character in his Tunisian specimens, so it may be concluded that it is exceedingly rare, and confined only to very well-preserved shells.

The largest lower valve of the Manuan Creek specimens shows the following dimensions:—

Length	25 mm.
Height	15 ,,
Diameter	15 ,,

The specimens from the north end of False Bay consist of isolated lower valves unconnected with matrix, belonging to young shells in different stages of growth. Internal characters are well developed, and even the sub-marginal denticles can be seen in some of the valves. These examples, like those from the Manuan River district, share a close resemblance with the Albian forms from England, as they occur at Blackdown, in Devonshire.

The largest lower valve from the north end of False Bay has the following dimensions:—

Length	38 mm.
Height	20 ,,
Diameter	15 ,,

The species appears to belong to the Upper Albian and Cenomanian stages of the Cretaceous period, having been recorded from Folkestone, Blackdown, Chute, Ireland, &c., in the British Islands; from numerous localities in Europe (France, Spain, Southern Italy, &c.), and from Northern Africa (Tunis and Algeria); it is apparently unknown either in Syria or India.

Localities.—Tributaries of the Manuan Creek, and north end of False Bay.

Exogyra, sp.

Plate II., figs. 11, 12.

Description.—Shell mostly of oblong form, with a smooth, lamellose external surface, and a large postero-medianly situated adductor scar impression. The upper valve is depressed, shallow, furnished with a posteriorly curved umbonal region, exogyriform; beneath the umbo extends a well-excavated margin curving outwards in its central part to circumscribe the ventral area; the anterior margin curves slightly outwards and may be said to be sub-parallel with the opposite border. The lower valve is thickest and most concave and its lateral margins are more or less parallel.

Dimensions (upper valve).—

Length	47 mm.
Height	77 ,,

Observations.—This description is drawn up from some isolated ostrœiform valves which are not capable of specific determination on account of belonging to different individuals which cannot be paired.

The most perfect of the specimens is an upper valve which, in conjunction with some fragmentary lower or more convex valves, appears to be referable to a smooth form of *Exogyra* having possible affinities with *E. sinuata*, J. Sowerby (=*Ostrea aquila*, Orbigny) which ranges from Barremian to Albian. The European species is, however, usually much wider and of more ponderous development than the present form, and is also prominently ridged. The valves from Zululand, which may represent only one species, are distinctly of different periods of growth, their height varying from 35 to 77 mm., the youngest being of quite a thin structure. It is their smoothness, exogyriform character, and lamellose structure which suggests a Lower Cretaceous type, such as *E. sinuata*, as their nearest grouping, which, if correct, would be in favour of a Lower Cretaceous age for the shells, more especially when it is remembered that the more ornamental forms of this genus, like *flabellata*, *africana*, *olisiponensis*, *suborbiculata*, &c., which are frequently found in Northern Africa (Egypt, &c.) belong to Upper Cretaceous horizons, chiefly Cenomanian. The valves were found associated with *Gervillia sublanceolata*.

Locality.—North end of False Bay.

Exogyra cf. flabellata, Goldfuss.

Plate II., figs. 6, 7.

Exogyra flabellata, Goldfuss, Petrefacta Germaniæ, 1833, vol. 2, pl. 87, fig. 6, p. 38.

Description.—Shell small, oval, and with strongly incurved umbones; upper valve flat, operculiform, obscurely plicated, and covered with concentric lines of growth; lower valve posteriorly deep, rounded, ornamented with concentric growth-lines and moderately thick plications; adherent surface in front, well excavated.

Dimensions.—

Length	15 mm.
Height	19 „
Depth of lower valve	11 „

Observations.—This small shell is in fair preservation, having both its valves united and closed, and still showing certain parts of the testiferous structure. The lower valve has a few well-marked nearly equidistant plications crossing the concentric growth-lines, and a similar ornamentation is seen on the operculiform upper valve, although the radial plications are much more obscure. The surface of the internal ventral margin of the lower valve is exposed for a short distance through the slightly smaller size of the other proving it to be excavated and radially striated.

With only one specimen, and that probably from its small size an immature one, it is difficult to institute comparisons so as to understand its relationship to any described species. The sculpture characters, however, seem to connect it with such a form as *Exogyra flabellata* of Goldfuss, a characteristic Cenomanian shell of European and Northern African localities.

The shell from Zululand is perhaps shorter than the normal form of *E. flabellata* although such a distinction may be due to age. The specimen also resembles *Ostrea boussingaulti*, Orbigny, as interpreted by Pictet and Renevier from the Aptian rocks of Switzerland (Desc. Foss. Terr. Aptien Perte du Rhone, *Mat. Pal. Suisse*, 1858, pl. 19, fig. 5, p. 140).

Locality.—Tributaries of the Manuan Creek.

Family PECTINIDÆ.

Genus NEITHEA, Drouet, 1825.

Mém. Soc Linn., Paris, 1825, vol. 3, p. 186.

Neithea quadricostata, J. Sowerby.

Plate II., figs. 18–21.

Pecten quadricostata, J. Sowerby, Mineral Conchology, 1814, vol. 1, pl. 56, figs. 1, 2, p. 121 (*non Janira quadricostata*, Orbigny, 1846).

Neithea quadricostatus, H. G. Bronn, Lethæa Geognostica, 1851–52, ed. 3, vol. 2, part v., p. 277, pl. 30, fig. 16.

Janira faucignyana, Pictet and Roux, Desc. Mollusques Foss. Grés Verts Genève, 1853, pl. 45, fig. 2, p. 505.

Janira tricostata, Coquand, Géologie et Paléontologie Constantine, 1862, pl. 13, figs. 3, 4, p. 219 (*non Pecten tricostatus*, Bayle, 1849).

Pecten quadricostatus, P. M. Duncan, *Quart. Journ. Geol. Soc.*, 1865, vol. xxi., p. 354 (S.E. Arabia and Bagh).

Janira tricostata, Lartet, Explor. Géol. La Mer Morte, 1877, pl. xi., fig. 16, p. 136.

Janira coquandi, Peron, *Bull. Soc. Géol. France*, 1877, ser. 3, vol. 5, pl. 7, fig. 2, pp. 504, 534.

Vola tricostata, Hamlin, *Mem. Mus. Comp. Zoology, Harvard College*, 1884, vol. x., No. 3, p. 61.

Neithea quadricostata, C. A. White, Contributions to the Palæontology of Brazil, *Archiv. Mus. Nac. Rio de Janeiro*, 1888, vol. 7, pl. 4, figs. 1, 2, p. 37.

Vola quadricostata, Blanckenhorn, Beiträge zur Geologie Syriens, 1890, p. 77.

Pecten coquandi, Peron, Desc. Mollusques Crétacés, *Explor. Scientif. Tunisie*, 1891, p. 224.

Pecten (Neithea) quadricostatus, H. Woods, Cretaceous Lamellibranchia England, *Mon. Pal. Soc.*, 1903, pl. 40, figs. 6, 7, and text figures, pp. 210–214.

Neithea quadricostata, Douvillé, *Bull. Soc. Géol. France*, 1904, ser. 4, vol. 4, p. 214.

Observations.—The specimens referred to this species represent a medium-sized lower or right valve, two similar valves of larger dimensions and with coarser details of structure, and the remains of an upper or left valve exhibiting an internal view of the costæ as they appear in the neighbourhood of the ventral border, the other part of the surface being covered by matrix. With the exception of this last specimen, which is of little or no account, the valves possess the characteristic details of sculpture generally associated with this species. Each pair of primary costæ encloses three rounded ribs, the central of which is slightly thicker and more prominent than the other two. The smaller right valve, which in contour and structure is the best preserved, has the costal surfaces and grooves near the ventral margin covered with microscopically fine concentric striations, whilst the fragmentary auricles are also delicately striated. The two coarser right valves are very imperfect so far as contour is concerned, and no auricles can be traced, but the costal system is well displayed, its ornamentation consisting of concentric ridge-like lines, resembling sometimes a series of irregular annulations.

Dimensions (of the right (=lower or convex) valve).—

	Small Example.	Large Example.	
Length	35	41 mm.	
Height	35	45 ,,	
Diameter	15	20 ,,	(about)

Besides the foregoing specimens, there is a much larger one showing a height of about 60 mm. and a diameter through the united valves of 23 mm. Parts of both valves are present, the posterior area being well preserved and exhibiting two fine radially curved parallel ribs equi-distant from each other, and immediately following the large marginal rib, which is crossed by a series of extremely fine and numerous growth striations. The ordinary lateral costæ are also well preserved in places, so that the microscopically small, concentric sculpture is definable with a good lens, otherwise the specimen is deficient in the umbonal and anterior regions. The lower part of the posterior auricle is present and forms a marked concavity in both valves. According to most authorities this species

has been regarded as of Cenomanian age entirely, but its occurrence in the Haldon and Blackdown Cretaceous deposits would suggest a greater antiquity, so that its range in time would be acknowledged as extending from Albian to Cenomanian, the latter in Britain being found in the *Pecten asper* zone of Warminster, Ventnor, Maiden Newton, &c., whilst those from European and other foreign localities have been reported from such countries as France, Germany, Holland, Austria, Switzerland, United States (Texas), &c., a key to which is to be found in the very complete synonymy of this species offered by Mr. H. Woods in his Monograph of British Cretaceous Lamellibranchia, published by the Paleontographical Society. It is of further interest to note that *N. quadricostata* occurs in Syria (Lartet, Hamlin, and Blanckenhorn), as well as in Northern Africa, such as Algeria (Coquand) and Tunis (Peron), whilst M. H. Douvillé has reported it from the north-west of Madagascar in rocks of Albian age, and several years since the late Dr. P. M. Duncan identified it among some fossils from the south-east of Arabia and also from Bagh on the Nerbudda in Afghanistan, which he attributed to the Cenomanian. According to Dr. Edgar Dacqué,* the species occurs in the Santonian beds of Egypt (Abu Roash, near Cairo), but this is probably an uncertain determination, because in the synonymy is included Bayle's *Pecten tricostatus*, as quoted by Blanckenhorn,† from the same locality, a species differing in certain features from Sowerby's *quadricostata*, and which, moreover, belongs to a much higher horizon of the Cretaceous series. As mentioned by Mr. H. Woods, the Senonian form figured by Orbigny as *quadricostata* being different from Sowerby's shell of the same name, was altered by Pictet and Campiche (Desc. Foss. Terr. Crét., St. Croix—*Mat. Pal. Suisse*, 1870, sér. 5, p. 253), to *Neithea* [Janira] *faujasi*, although this has since been regarded as synonymous with the *regularis* of Schlotheim (Choffat, Faune Crét. Portugal, 1901–1902, vol. 1, ser. 4, p. 149). Pictet and Campiche distinguished the Senonian shell by the presence of seven or eight ribs on the anterior and posterior outer surfaces instead of a fewer number as in the true *quadricostata* of J. Sowerby. It may also be recognised as a less angulate shell, the six leading costæ being of lesser elevation, so th the divisions are not so clearly separable. *Neithea faujasi* is very characteristic of the Upper Senonian deposits (Mæstrichtian) of Holland, and from rocks of similar age in Baluchistan, Dr. F. Nœtling having recorded its occurrence, but under the wrong specific determination of Sowerby's *quadricostata* (*Pal. Indica*, Mem. Geol. Surv.

* *Palæontographica*, 1903, vol. 30, part 2, p. 361.

† *Zeitschr. deutsch. geol. Ges.*, 1900, vol. 52, p. 39.

India, 1897, ser. 16, vol. 1, part 3, pl. xi., figs. 5–7, p. 42). It is alike interesting to note that in the Upper Cretaceous rocks of Brazil (province Sergipe), Dr. C. A. White has identified this species. According to Kossmat, on the evidence of the Cephalopoda, found in the same beds, the age of the Brazilian deposits may be regarded as Cenomanian.

It may be mentioned that Stoliczka has not acknowledged this shell as a member of the Southern Indian Cretaceous; he rather considers it capable of inclusion under *quinquecostata*, but as he states that there occur some large specimens from the Utatur beds of Odium, &c., showing three smaller ribs between the two larger ones, we may conclude that they represent this species.

Locality.—Tributaries of the Manuan Creek.

NEITHEA QUINQUECOSTATA, J. Sowerby.

Plate III., figs. 1, 2.

Pecten quinquecostata, J. Sowerby, Mineral Conchology, 1814, vol. 1, pl. 56, figs. 4–8, p. 122.

Neithea versicostata, Drouet, *Mém. Soc. Linn. Paris*, 1825, vol. 3, pl. 7, fig. 4, p. 187.

Pecten quinquecostatus, Forbes, *Trans. Geol. Soc. London*, 1846, ser. 2, vol. 7, p. 153; W. H. Baily, *Quart. Journ. Geol. Soc.*, 1855, vol. xi., p. 462.

Janira quinquecostata, Coquand, Géologie et Paléontologie Constantine, 1862, p. 292.

Pecten quinquecostatus, Griesbach, *Quart. Journ. Geol. Soc.*, 1871, vol. 27, p. 66.

Vola quinquecostata, Stoliczka, Cretaceous Pelecypoda, Southern India, *Pal. Indica*, 1871, vol. 3, pl. 31, figs. 1–6, and pl. 37, figs. 4–9, p. 437; Blanckenhorn, Beitrage zu Geologie Syriens, 1890, p. 77.

Pecten quinquecostatus, Peron, Desc. Mollusques Crétacés, *Explor. Scientif. Tunisie*, 1891, p. 227.

Vola quinquecostata, G. Müller in Bornhardt, "Deutsch-Ost-Afrika," 1900, vol. 7, pl. 24, fig. 1, p. 565.

Janira (*Vola*) *quinquecostata*, Kossmat, *Denksch. K. Akad. Wiss.*, 1902, vol. 71, p. 51.

Pecten (*Neithea*) *quinquecostatus*, H. Woods, Cretaceous Lamellibranchia England, *Mon. Pal. Soc.*, 1903, pl. 39, figs. 14–17, and pl. 40, figs. 1–5, p. 202.

Observations.—This species is represented by a single fragmentary lower valve which was found associated in the same matrix

with the adult form of *Veniella forbesiana.* The primary costæ are very prominent, each pair enclosing the four subsidiary ribs which characterise the shell, the laterals being usually smaller than the two centrals. Occasionally the minute sculpture of the shell is preserved, so that with the aid of a lens extremely fine and closely arranged concentric striations may be seen ornamenting the ribs and the intercostal spaces.

Dimensions.—

Length	35 mm.
Height	37 „
Diameter	15 „

According to Mr. H. Woods, who has published the latest views upon this species, *N. quinquecostata* has an extensive geological range, having been found in Britain in the so-called Lower Greensand deposits of Upware and Faringdon which form part of the Aptian series, and occurring also throughout the later Cretaceous divisions up to the *Micraster cor-anguinum* zone which belongs to the Santonian stage of the Emscherian or Lower Senonian strata, where the species apparently becomes extinct.

Mr. Wood's Monograph must be appealed to for a fuller synonymy of the species as only those references are given on the present occasion which deal chiefly with Indian and African occurrences. Southern Indian examples have been described by Forbes and Stoliczka, the latter author acknowledging the species in all three divisions of the Indian Cretaceous, viz., the Utatur, Trichinopoly and Ariyalur. Both Baily and Griesbach have determined specimens from the coast cliffs of S.E. Africa near Natal, the former recognising the shell's identity with the "Upper Greensand species from Warminster," whilst Mr. Griesbach determined his examples as similar to Forbes's from Pondicherry in Southern India.

Dr. Müller in his notice of the species from German East Africa (Kigua) regards it as of Cenomanian age. It is reported as occurring in the Upper Cretaceous rocks of the Island of Socotra by Dr. Kossmat. Dr. Blanckenhorn records it in the *Buchiceras syriacum* zone of Syria (= Cenomanian). In Algeria Coquand determined the species as of Rhotomagian age a term now regarded as equivalent to Cenomanian, and in Tunis Professor Peron recognised the shell as ranging from Cenomanian to the Danian.

Locality.—Tributaries of the Manuan Creek.

GENUS CAMPTONECTES, F. B. Meek, 1864.

Check List of the Invertebrate Fossils of North America—*Smithsonian Miscellaneous Collections*, 1864, p. 39.

CAMPTONECTES cf. CURVATUS, Geinitz.

Plate III., figs. 5, 6.

Pecten curvatus, Geinitz, Versteinerungen von Kieslingswalda, 1843, pl. 3, fig. 13, p. 16.

Camptonectes cf. curvatus, R. B. Newton, *Proc. Malac. Soc. London*, 1907, vol. 7, pl. 24, fig. 15, p. 284.

Observations.—This shell consists of a small left valve attached to the matrix displaying external characters. The auricular expansions are partially preserved, the anterior one having apparently broken away from the margin during fossilisation and stationed itself just below its normal position on the test, whilst only the slightest indication remains of the posterior ear. The ornamentation of the valve seems to connect it very closely with the *Pecten arcuatus* of Goldfuss, *non* J. Sowerby (Petrefacta Germaniæ, 1833, vol. 2, pl. 91, fig. 6, p. 50), from the Upper Cretaceous rocks of near Aix-la-Chapelle (= Aachen), Germany—a species which Mr. Henry Woods recognises as equivalent to the *curvatus* of Geinitz (*Mon. Pal. Soc.*, 1902, pl. 29, fig. 7, and pl. 37, fig. 16, p. 159). Closely arranged, bold, radiating ribs are observed curving outwards on each side, commencing from the centre where they are extremely fine and difficult to see without the aid of a lens; the minute grooval separations are obscurely punctated. Just before reaching the margin the ribs bifurcate, and consequently become finer and more numerous—a feature specially well seen on the postero-lateral region; fine annulations of growth also add to the sculpture of this specimen. Another point of interest is that it possesses two prominent red bands diverging from the umbo, and which probably extended to the ventral margin, which undoubtedly represent the position of original colour-markings. The colour of these bands as now preserved need not necessarily be the same as characterised the shell in life, as most probably the chemical agencies at work during the process of fossilisation entirely altered the nature of the original pigment. With the view of exhibiting these so-called colour-bands, this specimen was recently figured among some other fossil mollusca exhibiting various markings attributable to colour (R. B. Newton, *Proc. Malac. Soc. London*, 1907, vol. 7, pl. 24, fig. 15, p. 284). Judging from the figures of *Camptonectes curvatus*, as determined by Stoliczka from the Ariyalur and Trichinopoly groups of Southern India. (Cretaceous Pelecypoda, Southern India, *Pal. Indica*, 1871, pl. 31, figs. 15,

16, and pl. 41, figs. 4–6, p. 433), the shell from Zululand seems to show a favourable relationship although the absence of specimens for purposes of comparison militates against any investigation to prove such a point with absolute success.

Dimensions.—

Length .... 17 mm.
Height .... 19 „

Locality.—Tributaries of the Manuan Creek.

Genus SYNCYCLONEMA, Meek, 1864.

Check List of the Invertebrate Fossils of North America.—*Smithsonian Miscellaneous Collections*, 1864, p. 7.

Syncyclonema orbicularis, J. Sowerby.

Plate III., figs. 3, 4.

Pecten orbicularis, J. Sowerby, Mineral Conchology, 1817, vol. 2, pl. 186, p. 193.

Pecten laminosa, Mantell, Geology of Sussex, 1822, pl. 26, figs. 8 and 22, p. 128.

Pecten (Syncyclonema) orbicularis, Stoliczka, Cretaceous Pelecypoda, Southern India, *Pal. Indica*, 1871, vol. 3, p. 428.

Syncyclonema orbicularis, R. B. Newton, Proc. Dorset Nat. Hist. Antiq. Field Club, 1897, vol. 18, pl. 3, fig. 9, p. 84.

Pecten (Syncyclonema) orbicularis, H. Woods, Cretaceous Lamellibranchia, England, *Mon. Pal. Soc.*, 1902, pl. 27, p. 145.

Observations.—This species is represented by a single valve attached to the matrix exhibiting external characters, which from its apparently smooth surface and the nature of its auricles may be regarded as an upper or left valve. The height slightly exceeds the length; it is gently convex; the left ear, although fractured, is observed to be longer, rather narrower, and more oblique than the other, and both have sub-angulate dorsal extremities. The ornamentation, only distinguishable with a lens, consists of closely set, minute, concentric ridges and sulcations beautifully preserved, especially on the dorsal half of the valve, otherwise in the ventral region the original shell structure appears to be absent, except perhaps near the margin, where evidence of similar sculpture can be also obtained. The surface of the right auricle is seen to possess the usual delicate transverse striations or growth-lines of the species.

Dimensions.—

Length .... 27 mm.
Height .... 30 „

The type is recorded from the "Greensand" of Devizes, and is

probably of Cenomanian age. There are few species acknowledged to have so extensive a geological range as *S. orbicularis*. According to the latest views, as contained in Mr. H. Woods' memoir (*Mon. Pal. Soc.*), it occurs in the Neocomian of Brunswick (= *P. Germanicus*, Wollemann, *Abhandl. d. k. preussisch. Geol. Land.* 1900 (N.F.). pt. 31, pl. 8, figs. 13–19, p. 41), and is to be found in all the succeeding stages of the Cretaceous deposits right up to the *Holaster subglobosus* zone of the Cenomanian series. It is easily seen, as pointed out by Mr. Woods, that some variations exist in this species, and that according to particular environment the valves may differ slightly in size, proportions, ornamentation, and even convexity. It is so with the Haldon examples, a large series of which are in the British Museum forming part of the William Vicary collection, and which Mr. Woods regards as a local variety under the name of *P. orbicularis* var. *haldonensis*, because of the usually larger auricles, smaller apical angle, straight antero- and postero-dorsal margins, numerous ribs, and with a proportionally higher valve. It is to this group the specimen from Zululand belongs as after a strict comparison, the details of structure are found to be in every respect the same as distinguishes the Haldon specimens.

The species appears to be restricted to the British Isles and Central European localities, there being no records of its occurrence in either Africa or India. With regard to India, it may be mentioned that Stoliczka has described and figured two forms of *Syncyclonema* (*obovatus* and *sivaicus*) from the Utatur group of Southern India, which show the general features of *S. orbicularis* and are doubtless closely related, but without actual specimens for examination it is difficult to grasp their true affinities. The reference to Stoliczka in synonymy does not imply the existence of an Indian example—it is merely taken from a list of species in which Meek's genus *Syncyclonema* is apparently used for the first time in connection with this species.

An Annelid-tube belonging to the genus *Serpula* (see p. 96) is in the same matrix with this specimen. It is about 30 mm. in length, of wide and gentle curvature, possessing a nearly uniform diameter (3 mm.), and ornamented with closely set annulations, the more elevated of which frequently enclose less prominent rings of quite microscopic size; the tube is slightly bulbous in places, especially where the periodical constrictions occur. The transverse section exhibits a circular outline and a wall of about 1 mm. in thickness. This specimen shows certain resemblances to *S. pinchiniana* (Tate) var. *umsinenensis* of R. Etheridge from the Umsinene River deposit (W. Anderson, "Third Report Geol. Surv. Natal and Zululand," 1907, pl. 1,

figs. 1–6, p. 68), and also to an unnamed species found in the Gault and Blackdown Beds of England, but without attempting the further determination of such a specimen, a record of its association with the present pectinoid-shell may be of some interest to palæontologists in adding to the Cretaceous fauna of this area of Africa.

Locality.—Tributaries of the Manuan Creek.

Family LIMIDÆ.

Genus LIMA, Chemnitz, 1784.

Conchylien-Cabinet, 1784, vol. vii., p. 352.

Lima cf. gaultina, H. Woods.

Plate III., figs. 18, 19.

Plagiostoma elongata, J. de C. Sowerby, Mineral Conchology, 1827, vol. 6, pl. 559, fig. 2 (upper figure).

Lima parallela, Orbigny, Pal. Française Terr. Crétacés, Lamelli branchia, 1845, pl. 416, figs. 11–14, p. 539, *non Modiola parallela*, J. Sowerby; R. B. Newton, *Proc. Dorset Nat. Hist. Antiq. Field Club*, 1897, vol. 18, pl. 3, fig. 11, p. 88; Jukes-Browne and Hill, Cretaceous Rocks of Britain, Gault, &c., *Mem. Geol. Surv. United Kingdom*, 1900, vol. 1, p. 467.

Lima (*Mantellum*) *gaultina*, H. Woods, Cretaceous Lamellibranchia England, *Mon. Pal. Soc.*, 1904, pl. 5, figs. 16–20, p. 31.

Description.—Shell inflated more or less cylindrical, arched from an oblique umbonal area to the ventral border; anterior side short and rounded; posterior region obliquely produced, deep, nearly vertical, and rounded at extremity; dorsal and ventral margins parallel; sculpture consisting of about 18 radial costæ divided by shallow sulcations, which anteriorly are very obscure and quite extinct on the posterior side; obscure concentric growth striations are also seen, these being directed upwards on the posterior side and forming lines nearly parallel with its outer margin; umbo very anterior (apex absent).

Dimensions (left valve).—

Length	15 mm.
Height	23 „
Diameter	7 „

Observations.—The specimen described consists of a left valve in the condition of a cast attached to the matrix, showing external features. Neither the hinge-line nor the umbonal apex are pre-

served; otherwise, the convexity of the valve, its sculpture, its rounded margins, and generally sub-cylindrical appearance are noticeable details of its structure. It is evidently more closely allied to the *Lima* (*Mantellum*) *gaultina* of H. Woods (= *Plagiostoma elongata*, J. de C. Sowerby and *Lima parallela*, Orbigny), from British and European Albian deposits, than to any other species. That form, however, is furnished with depressed valves, and is consequently wanting in the sub-cylindrical character of the present shell.

In well-preserved examples of *L. gaultina* the radial costæ are angulated at the sides and have rather sharp summits, but in the cast these details would not be preserved and the ribs would be much rounder than they originally might have been. There is no indication in the valve described of an intermittent rib between the costæ such as distinguishes J. Sowerby's *Modiola parallela* from rocks of Lower Cretaceous age, and which even in casts is usually preserved. Tate's *Lima neglecta* (*Quart. Journ. Geol. Soc.*, 1867, vol. 23, pl. 7, fig. 4, p. 156), from the Uitenhage formation of South Africa is also a closely allied form, being of similar axial proportions, having much the same costal ornamentation, although possessing valves of rather less convexity.

Again *Lima numidica*, of Thomas and Peron (Desc. Mollusques Crétacés, *Explor. Scientif. Tunisie*, 1891, pl. 27, fig. 2, p. 217), from the Cenomanian of Northern Africa (Tunis) is of somewhat similar structure to the foregoing species, although differing in its longer posterior side, its relatively greater antero-posterior measurement and more numerous costæ. It is of interest also to note that Stoliczka does not recognise this form of *Lima* in the Indian Cretaceous.

Locality.—Tributaries of the Manuan Creek.

Family SPONDYLIDÆ.

Genus PLICATULA, Lamarck, 1801.

Syst. Anim. sans Vert., 1801, p. 132.

Plicatula andersoni, sp. nov.

Plate II., figs. 15–17.

Description.—Shell small, oblique, triangulate, obtusely pointed above, depressed, inæquilateral, slightly inæquivalve, height and length equal; anterior margin short, directed obliquely from the umbo, afterwards merging into the fan-shaped curvature of the

ventral border; posterior margin oblique, elongate, rounded at ventral extremity; upper valve flat, slightly convex near umbo, and a trifle smaller than opposing valve; lower valve moderately convex; sculpture on both valves consisting of numerous convex, radial costæ occasionally interrupted by concentric periodical growth-lines; costæ bifurcating about the middle of the valve, imbricated and furnished with small tubular spinose projections at the various margins of growth; the costæ are separated by shallow sulcations.

Dimensions.—

Length	19 mm.
Height	19 „
Diameter	7 „

Observations.—The above description is founded upon a small specimen with both valves standing slightly open, of which the umbones are not preserved. Although the ornamentation of the valves is on the same plan in each, yet the lower has longer and more developed tubular spines which extend occasionally beyond the margins, whilst the upper valve is comparatively smooth from the fact that the tubular terminations of the costæ are shorter and do not overlap the border. The specimen shows affinities with *Plicatula aspera** (J. de C. Sowerby, *Trans. Geol. Soc. London*, 1832, ser. 2, vol. 3, pl. 38, fig. 7) from the Upper Cretaceous deposits of Gosau, Austria—a species which apparently differs by possessing a flat or slightly concave upper valve, as well as having less oblique sides and consequently a less triangulate contour, and in addition the costæ, although as crowded, are not so straight as in the specimen now described. Slight resemblances are traceable with *P. multicostata* of Forbes as emended by Stoliczka (Cretaceous Pelecypoda, Southern India, *Pal. Indica*, 1871, pl. 34, figs. 15–18, pl. 46, figs. 5, 6, p. 446) from the Trichinopoly group of Southern India, but the valves of the present shell have a more obliquely oval form and are ornamented with more regular and straighter costæ.

A number of Plicatulæ are recorded from the Upper Cretaceous rocks of Northern Africa, especially by Coquand in connection with Algeria, Zittel and others in respect of Egypt, and Blanckenhorn

* It may be here noted that Sowerby's *Plicatula aspera* was based entirely upon a figure without description. In 1846 Orbigny (Pal. Française Terr. Crétacés Lamellibranchia, 1846, pl. 463, figs. 11, 12, p. 686) purported to describe and illustrate the same form as found in France, but, as pointed out by Stoliczka, "this can hardly be regarded as identical with the one from the Gosau" formation. The true interpretation of the old Sowerby figure is, however, to be found in Zittel's excellent drawings and description of specimens found in the same beds of the Austrian Tyrol (*Denkschr. k. Akad. Wiss.* [Wien], 1866, vol. 25, pl. 19, fig. 1, p. 120).

with regard to Syria. The forms described and figured, however, considerably differ from the Zululand specimen both in point of contour and in the ornamentation of the valves. So far as can be ascertained, no specimens of this genus have been recorded from Natal or other Cretaceous localities of Southern Africa.

The species is named after Mr. William Anderson, F.G.S., the discoverer of the fossils forming this collection, and who at that time was Government Geologist of Natal.

Locality.—Tributaries of the Manuan Creek.

Plicatula rogersi, sp. nov.

Plate II., figs. 13, 14.

Description.—Specimen consisting of an upper valve exhibiting an obliquely orbicular contour with a generally depressed external surface but with a slightly concave ventral margin; the apex and lower part of the right lateral border are not preserved. The sculpture shows well-marked concentric growth-lines crossed by six or seven very slightly convex radial costæ which emanate from the umbonal region, though a good deal obscured before reaching the ventral border. The costæ broaden out in front, as do the shallow grooves which separate them, whilst the extreme one to the right appears to be bifurcated. Internally the specimen is furnished with a broad, smooth, rounded margin, the inner border of which, forming the pallial line, bears a single row of small, distant tubercles placed at almost equal distances apart and extending from the dental region throughout this circumscribed portion of the valve. A large circular eccentric adductor scar-marking is also present, as well as the remnants of two distant cardinal teeth projecting from each side of the dental area, which are divided by a worn excavated space.

Dimensions.—

Length	(about)	30 mm.
Height	(about)	35 ,,
Thickness of shell structure		5 ,,

Observations.—It is difficult to institute a comparison when only one valve is available for study, but incidentally it may be mentioned that on account of its few costæ there is a resemblance to *P. paucicostata* of Sequenza from the Turonian-Cenomanian series of Southern Italy (*Atti R. Accad. Lincei* [Roma], 1882, vol. 12, ser. 3, pl. 15, fig. 7, p. 170), but in that form there is a more elongate outline, and moreover the costæ extend to the ventral margin and set up a plicated character which is absent in the

smoothly margined form from Zululand. A number of Plicatulæ have been recorded from the Cretaceous rocks of Southern India, Northern Africa, &c., but as a rule they possess a greater number of radial ribs, a more complicated structure, with frequently asperities, spines, or imbrications. In similar details it cannot be mistaken for *P. andersoni* from the Manuan Creek deposits described in the present memoir. The tubercles referred to as present on the internal face of this valve is a structure very seldom referred to in connection with the genus *Plicatula*, although they can be traced in some of the modern species.

I wish here to convey my thanks to the artist, Mr. A. H. Searle, for pointing out this structure, which on a first examination was regarded as mineralogical, but which, from its regularity, is doubtless of an organic character.

The specific name is in honour of A. W. Rogers, Esq., M.A., F.G.S., Director of the Geological Survey of Cape Colony, and author of a volume entitled, "An Introduction to the Geology of Cape Colony," published in 1905.

Locality.—North end of False Bay.

Family CYPRINIDÆ.

Genus VENIELLA, Stoliczka, 1871.

Cretaceous Fauna Southern India; The Pelecypoda, *Pal. Indica*, 1871, p. 189 = *Venilia*, Morton, 1834, Synopsis Organic Remains Cretaceous, United States, 1834, pl. 8, figs. 1, 2, p. 67 (preoccupied).

Veniella forbesiana, Stoliczka.

Plate VII., figs. 1–4.

Cyprina forbesiana, Stoliczka, Cretaceous Pelecypoda, Southern India, *Pal. Indica*, 1871, vol. 3, pl. 9, figs. 2–8, p. 197.

Veniella forbesiana, F. B. Meek, Report on the Invertebrate Cretaceous and Tertiary Fossils of the Upper Missouri Country, *United States Geol. Surv. Territories*, 1876, vol. 9, p. 150 (reference only—species not found in America).

Cyprina forbesiana, Peron, Desc. Mollusques, Crétacés, *Explor. Scientif. Tunisie*, 1891, pl. 29, figs. 4, 5, p. 295.

Roudaireia forbesiana, Pervinquière: Étude Géologique Tunisie Centrale (Paris), 1903, p. 151.

Roudaireia forbesi, Choffat, Nouvelles Données sur la zone Littorale d'Angola, *Com. Service Géol. Portugal*, 1905, pl. 1, fig. 3, p. 42.

Observations.—With the exception of dental and other internal characters, which are not displayed, the specimens referred to this species conform in every way externally to the shell originally described and figured by Stoliczka as a characteristic member of the Trichinopoly fauna of Southern India. Its ornamentation and contour distinguish it from other forms of the genus, being trapezoidal having strongly incurved anterior umbones excavated beneath to form the lunule, and a prominently arched carina extending from the umbo to the postero-ventral angle, which encloses the abrupt, deep, medianly inflated posterior area. The sculpture consists on the anterior side of equidistant, concentric, elevated laminæ, divided by finely striated, shallow sulcations of nearly equal width throughout; the surface of the posterior region shows a central ridge-like elevation emanating from the umbo and running parallel with the curved carina, which becomes more or less obscured as it extends in the infero-posterior direction; and in addition the surface of the area is ornamented with an unbroken series of closely arranged oblique striations.

Among the examples of this species four represent a medium, and one an adult growth, the latter being in a fine state of preservation, possessing both valves in the closed condition, and which, moreover, are properly *in situ.* It is only right to mention that this specimen was skilfully denuded of its matrix by Mr. C. P. Chatwin, of the Geological Department of the British Museum; except that it is rather less in size this specimen agrees in every detail with the Indian form represented on Stoliczka's pl. 9, figs. 6–6*c*; associated with it was the convex valve of *Neithea quinquecostata.*

Dimensions (adult specimen with both valves).—

Length	62 mm.
Height	70 ,,
Diameter	55 ,,

The maximum length of the Indian shell is given as 75 mm.

According to Stoliczka (Cretaceous Pelecypoda, Southern India, *Pal. Indica*, 1865, p. 90) *Ammonites tamulicus* of Blanford occurs in the Trichinopoly group of different Southern Indian localities, similar places being given by the same author for *Cyprina forbesiana.* Such beds are regarded by Kossmat as of Lower Senonian age or the upper part of the Trichinopoly series (see *Records Geol. Surv. India*, 1897, vol. 30, p. 82—Correlation Table), the Cephalopod being now recognised by that author as *Placenticeras tamulicum* (*Beitr. Pal. Geol. Österr.—Ungarns*, 1895, vol. 9, parts 3 and 4, p. 174).

M. Alphonse Peron has described and figured this species from the Turonian rocks of Tunis, Dr. Pervinquière mentions its occurrence in the Senonian of the same country, whilst M. Paul Choffat records it from the Senonian of Angola, Western Africa.

The generic name of *Veniella* was substituted by Stoliczka for Morton's *Venilia* of 1834, which had been previously used by Duponchel for a Lepidopterous insect in 1829, the type species being *Venilia Conradi* of Morton (Synopsis of the Organic Remains of the Cretaceous Group of the United States, 1834, pl. 8, figs. 1, 2, p. 67). The hinge characters of this genus agree in every way with *Cyprina* (= *Arctica*), the chief difference being that the middle tooth is more massive and sometimes, as in the type, of trigonal shape. External characters have, however, been considered of sufficient importance for the separation of *Veniella* from *Cyprina*.

Meek has remarked upon Stoliczka's inconsistency in not regarding the two Indian Cretaceous species *Cyprina forbesiana* and *C. cristata* as belonging to *Veniella*, and he quotes Conrad as his authority for regarding them as that genus—a plan adopted on the present occasion. With some typical examples for comparison, it is possible that *Cicatrea* of Stoliczka, founded on the Indian Cretaceous shell *Cyprina cordialis*, of the same author (Cretaceous Pelecypoda, Southern India, *Pal. Indica*, 1871, pl. 10, fig. 1, pp. 192, 199), as well as *Roudairia* of E. P. Munier-Chalmas (type *R. drui*, Mun.-Chalm.), from the Senonian of Tunis (Mission M. le Com. Roudaire Chotts Tunisiens, 1881, pl. 4, figs. 1–16, pp. 74–77) would be absorbed by Morton's earlier *Venilia* = *Veniella*. It is of interest also to note that *Cicatrea* and *Roudairia* have been regarded as synonyms by M. Douvillé in connection with some studies on the palæontology of Madagascar (*Bull. Soc. Géol. France*, 1904, ser. 4, vol. 4, fasc. 2, p. 216).

Locality.—Tributaries of the Manuan Creek.

Veniella etheridgei, sp. nov.

Plate VII., figs. 5, 6.

Description.—Shell with large sub-depressed, trapezoidal, thickly tested valves; umbones strongly incurved and anterior from which proceeds to the postero-ventral angulation a prominently curved ridge dividing a deep, almost vertical posterior area from the anterior face of the shell; beneath the umbones is an extensive shallow excavation representing the lunule, although not clearly defined on account of the presence of the growth striations; sculpture consisting, on the anterior region, of numerous concentric striations which

are finest on the umbonal area but afterwards coarser with age, and divided into more or less regular groups according to the periodical growth-lines of the shell; the posterior area is covered with closely arranged oblique striations forming angulations at the ridge as they pass over from the anterior face. Hinge area wide with a strong dentition, possessing in the left valve a massive central cardinal tooth, united at the base by a stout nearly horizontal fulcrum to the succeeding anterior tooth, and divided from the latter by deep and comparatively narrow sockets; between the posterior (only slightly indicated) and middle cardinal tooth is a deep and more or less trigonal socket; a large smooth excavation, representing the position of the adductor muscle, occurs at the imperfect end of hinge area.

Dimensions (left valve).—

Length	(about)	100 mm.
Height	,,	90 ,,
Umbonal ridge (length)		160 ,,
Posterior area (width)		35 ,,
Thickness of shell structure beneath the anterior end of hinge region		15 ,,

Observations.—The specimen described is of fragmentary character, retaining parts of both valves, although only the left has been selected for characterisation on account of the right valve being mostly in the condition of an internal cast. The form is evidently closely allied to *V. forbesiana*, but differs in its larger and more ponderous size, and its more massive hinge area; the sculpture is more regular, the elevated lamelliform costæ being absent; and further, the umbonal ridge is more obtuse. The valves are slightly open, showing the anterior dental character of the left valve, the incurved summits being about 15 mm. apart. The major part of the right valve is represented by an internal cast, showing a narrow, elongate, and rounded umbonal area with a lengthy and spreading ventral region, besides large adductor scar markings and pallial line, which are well impressed.

There is a second specimen representing the exterior of a left valve of medium size, measuring about 70 mm. in both directions, which most probably belongs to this species, but it is so imperfect in the ventral direction and so covered with matrix, that some uncertainty exists as to its identification. The prominent umbo-ventral ridge is, however, present together with the partly preserved posterior area, which is very abrupt and of considerable depth. Some similarity is also seen between this specimen and *Veniella (?) sanctæ-luciensis*, of R. Etheridge, jun., from the Umsinene River deposit of Zululand (in Mr. Anderson's "Third and Final Report of the Geological Survey of

Natal and Zululand," 1907, pl. 3, figs. 1, 2, p. 79), although, according to Mr. Etheridge's figure 2, the posterior slope does not appear to be so steep as in the present specimen, which has a width of 20 millimetres. The softer and more marly deposits of the Manuan Creek district have also yielded a fragmentary specimen of this species which must have been of similar size to the foregoing, the posterior area having a width of 20 mm. The external sculpture of this example is in excellent condition.

Some small adherent Annelids (see p. 97) are present on the lateral face of the large cast, having a diameter of ·5 mm. They may be mentioned as of circular outline, flattened, composed of five or six contiguous volutions and resembling a Cretaceous form from New Jersey, described and figured by Morton as *Vermetus rotula* (Synopsis of the Organic Remains of the Cretaceous Group of the United States, 1834, pl. 1, fig. 14, p. 81).

An adherent Polyzoan should also be observed on the external surface of the left valve, which appears to belong to the genus *Membranipora* (see p. 96).

The species is named in honour of Mr. R. Etheridge, Curator of the Australian Museum, Sydney, and author of some valuable reports on the palæontology of Zululand.

Locality.—Tributaries of the Manuan Creek.

Family MACTRIDÆ.

Genus MACTRA, Linnæus, 1767.

Systema Naturæ, 1767, edition xii., vol. 1, p. 1125.

Mactra (?) rupert-jonesi, sp. nov.

Plate VI., figs. 16, 17.

Description.—Shell transversely oval, inflated, thick, nearly equilateral; anterior margin rounded; posterior region wide (23 mm.), deep, oblique, obtusely angulate from umbo to postero-ventral angle, outer margin truncate; umbonal region elevated, ventricose, curved; lunule apparently wide, shallow, not properly defined; ornamentation consisting of fairly closely arranged concentric striations divided by rather coarser and somewhat distant periodical growth-lines.

Dimensions (specimen with closed valves).—

Length	47 mm.
Height	40 ,,
Diameter	30 ,,

Observations.—This form of Mactroid-shell is represented by a single specimen with closed valves, the umbones of which have been destroyed, as well as the details of the hinge area. Notwithstanding the absence of the actual umbones, a view of the left valve exhibits a well-elevated and beautifully rounded umbonal region situated almost in the centre of the shell and margined posteriorly by an obtuse angulation which terminates at the postero-ventral corner. The hinge-line is nearly horizontal and not laterally oblique as in most examples of the genus *Mactra*, so that the general contour is quadrate rather than triangular. Among Cretaceous species referred to the genus *Mactra*, and to which the present shell may be related, is *M. valangiensis* of Pictet and Campiche (*Mat. Pal. Suisse*, 1865, pl. 8, fig. 9, p. 127) from the Lower Neocomian of Sainte-Croix, Switzerland. This species was founded upon a cast showing both valves in the closed condition, being in contour and dimensions curiously like the specimen from Zululand, but without actual examples for comparison it is difficult to say with accuracy how far they resemble each other. If anything, the Swiss shell seems to be rather more oblique at the anterior margin, whilst the posterior area is less defined and much narrower, measuring only 10 mm. across, whereas the African shell shows a width in that region of 23 mm.

Again, Pictet and Roux's *Mactra gaultina* from the "Grès Verts" of Perte-du-Rhône (Desc. Moll. Foss. Grès Verts Genève, 1852, pl. 29, fig. 3, p. 407) differs from the present species in having compressed valves, a nearly horizontal ventral margin, and a relatively longer axis. The casts from the Cenomanian of Constantine figured and described by Coquand (Géol. Pal. Constantine, 1862, pl. vii., figs. 1–4, pp. 190, 191) as *Mactra didonis*, and *M. mævusi* are both too trigonal for confusion with this species, as also are two shells described by Forbes from the Southern Indian Cretaceous as *M. tripartita* and *Cardium intersectum* (see Stoliczka, Cretaceous Pelecypoda, Southern India, *Pal. Indica*, 1871, vol. 3, pl. 5, figs. 8–11, p. 57).

It is extremely doubtful whether some of the Cretaceous forms of this genus hitherto described, about which the dentition is unknown, are really *Mactra* or not; it is therefore necessary in the present case to query the generic determination. The species is dedicated to Professor T. Rupert Jones, F.R.S., in admiration of his early researches on the geology of South Africa.

Locality.—Tributaries of the Manuan Creek.

Family VENERIDÆ.

Genus VENUS, Linnæus, 1758.
Systema Naturæ, 1758, edition x., p. 684.

Venus, sp.
Plate VI., figs. 10–12.

Description.—Shell globose, thick, length and height about equal; umbones contiguous, antero-central, incurved; lunule cordiform, wide, well defined; posterior end broad, circumscribed in the cast by an obtuse keel on each side curving gently from the umbones to the ventral region, and which would represent in the shell an elongate groove running obliquely from beneath the umbo to the antero-basal margin of the posterior muscular scar; sculpture consists of concentric ridges and sulcations in close and regular arrangement ornamented with numerous microscopically fine vertical striations.

Dimensions (specimen with closed valves).—

Length	40 mm.
Height	40 ,,
Diameter	30 ,,

Observations.—Unfortunately, there is only one example of this shell in the collection, which is so very fragmentary that the posterior half is stripped of its testiferous structure, a reddish-brown matrix beneath filling the valves and so forming an internal cast of the posterior region. Parts of both valves are, however, preserved, these being united and in the closed state; the anterior area, especially of the left valve, is well covered with a strong, robust shell material showing a thickness of 2 mm. The umbones are obscure and imperfect, though their incurved character can just be seen, beneath being the wide and well-defined lunule, this being succeeded by a prominently rounded margin which is continued to the ventral border. The tumidity of the valves and their well-sculptured sides, together with the broad posterior end makes this a singularly striking shell, but the absence of dental characters creates a difficulty as to its true generic position, although the *tout ensemble* compares favourably with that of a modern *Venus*, such as the *rugosa* of Chemnitz, which is furnished with similarly tumid valves, a concentrically ridged ornamentation, a prominent lunule, a short rounded anterior region, besides an extensive and well-curved posterior margin. The sculpture of the present shell also agrees with that characterising J. de C. Sowerby's *Venus caperata* from the Blackdown beds (= Albian) of England, but this latter has more depressed valves, besides being of a lighter and more delicate

structure, whilst the lunule is inconspicuous and much smaller. The specimen appears to be distinct from any shell yet described from either Africa or India, and although imperfect its notice on this occasion may lead to the acquisition of better material in the future when its determination may be made more secure.

Locality.—Tributaries of the Manuan Creek.

Genus MERETRIX, Lamarck, 1799.

Mém. Soc. Hist. Nat., Paris, 1799, p. 85.

Meretrix cf. caperata, J. de C. Sowerby.

Plate VI., figs. 13–15.

Venus caperata, J. de C. Sowerby, Mineral Conchology, 1826, vol. 6, pl. 518, figs. 1–3, p. 31; Orbigny, Pal. Française Terr. Crétacés Lamellibranchia, 1843–1846. pl. 385, figs. 9, 10, p. 445, and Prodrome de Paléontologie, 1850, vol. 2, p. 159 (No. 276).

Cytherea caperata, Jukes-Browne and Hill, Cretaceous Rocks of Britain, Gault, &c. *Mém. Geol. Surv. United Kingdom*, 1900, vol. 1, p. 466.

Observations.—There is only one example of this small form of *Meretrix* in the collection. It has both valves united and closed, and is probably allied to that originally described by Sowerby under the name of *Venus caperata*, from the Blackdown beds of England. The valves are considerably worn, although some remains of concentric sculpture are still preserved, especially on the postero-umbonal region, which appear to represent the regularly cut ridges and sulcations characteristic of this species. In the ventral direction the surface is much smoother, erosive conditions having evidently destroyed the sharpness of the original ornamentation. In contour and dimensions this specimen compares most favourably with examples from Blackdown, except perhaps the oblique posterior margin may be relatively shorter. The valves, however, exhibit the same degree of convexity, a similar sub-trigonal outline, a small cordiform lunule, and an elongate, narrow escutcheon area in which the mineralised remains of the original ligament can be obscurely seen.

Dimensions.—

Length	27 mm.
Height	25 ,,
Diameter	15 ,,

According to Jukes-Browne's table of fossils in the Geological Survey Memoir the true *caperata* is restricted in Britain to the *Ammonites rostratus* zone of the Albian series, having been recorded from

Lulworth, in Dorsetshire; the Isle of Wight; and from Blackdown, Haldon, and Sidmouth, &c., in Devonshire. Judging from the numerous specimens occurring at Blackdown, it is probably more characteristic of that locality than any other. The French example figured by Orbigny is an internal cast without any vestige of ornamentation; its locality being given as from the neighbourhood of Tours (Indre-et-Loire). There appear to be few records of this species, and so far as can be ascertained no specimens have been reported from either Africa or India.

Locality.—Tributaries of the Manuan Creek.

MERETRIX ANDERSONI, sp. nov.

Plate VI., figs. 7–9.

Description.—Shell sub-oval, moderately convex; umbones anterior, small, contiguous; anterior margin short, rounded, prominently excavated beneath the beaks to form the lunule, the latter being small, well inscribed and cordiform; posterior margin depressed, oblique, produced, enclosing a long, narrow escutcheon groove; postero-ventral end narrow and sub-angulate; ventral margin ovally curved, extensive; sculpture consisting of numerous, close, equidistant, concentric ridges and deeply impressed sulcations.

Dimensions.—

	Small Example with Closed Valves.	Large Example, Right Valve.
Length	25	30 mm.
Height	19	23 ,,
Diameter	10	8 ,,

Observations.—This shell appears to be of an intermediate character between J. de Carle Sowerby's *Venus faba* and *V. ovalis*, originally described from the Blackdown deposits (= Albian) of England. From the first-named it differs in possessing more oblique or cuneiform and less compressed valves, and from *V. ovalis*, it can be separated by its lesser convexity and straighter posterior margin. The sculpture of the African shell is also a good deal more regular and decided than that characterising the two species just mentioned. Certain shells have been described and figured by Stoliczka (Cretaceous Pelecypoda, Southern India, *Pal. Indica*, 1871, pl. xvi., figs. 31–33, p. 174), which show a similarity of ornament, among them being *Cytherea* (*Callista*) *fabulina* of that author which exhibits all the regularity of sculpture seen in the fossil from Zululand, but which has a relatively shorter contour and a much smaller tendency to a postero-ventral attenuation. The *Venus faba* of Orbigny (Pal. Française Terr. Crétacés, Lamellibranchia, 1843–1846, pl. 385,

figs. 6–8, p. 444), which, however, differs from Sowerby's type in possessing a much stronger concentric sculpture, shows a rounder and wider posterior region; otherwise it is probably the form which comes nearest to the present species. A remarkable resemblance may also be noted with the figure of Möricke's *Venus* (*Cytherea?*) *pacifica* from the "Quiriquina-Schichten" (= Aturian or Upper Senonian) of Chili, South America (*Neues Jahrb.*—Beilage-Band, x., pl. 7, fig. 7, p. 103).

Locality.—Tributaries of the Manuan Creek.

Family CARDIIDÆ

Genus PROTOCARDIA, Beyrich, 1845.

K. T. Menke's Zeitschrift für Malakozoologie, pp. 17–20.

Protocardia hillana, J. Sowerby.

Plate V., fig. 16.

Cardium hillanum, J. Sowerby, Mineral Conchology, 1813, vol. 1, pl. 14 (upper figure), p. 41; Orbigny, Pal. Française, Terr. Crétacés, Lamellibranchia, 1843, pl. 243, p. 27; E. Forbes, *Trans. Geol. Soc. London*, 1846, ser. 2, vol. 7, p. 146.

Protocardia hillana, Geinitz, Grundriss Versteinerungskunde, 1846, vol. 2, pl. xix., fig. 4, p. 421.

Cardium hillanum, Coquand, Géologie et Paléontologie, Constantine, 1862, p. 291.

Cardium (*Protocardia*) *hillanum*, Zittel, *Denkschr. k. Ak. Wiss.* (Vienna), 1864, vol. xxiv., pl. 7, figs. 1, 2, p. 146.

Protocardium hillanum, Stoliczka, Cretaceous Pelecypoda, Southern India, *Pal. Indica*, 1871, pl. xii., figs. 8–10, pl. xiii., figs. 1–3, p. 219.

Cardium hillanum, Griesbach, *Quart. Journ. Geol. Soc.*, 1871, vol. 27, p. 62.

Cardium hillanum var. *moabiticum*, Lartet, Explor. Géol. La Mer Morte, 1877, pl. xi., fig. 5, pl. xii., fig. 9, p. 130.

Cardium hillanum, Seguenza, *Atti R. Accad. Lincei* (Roma), 1882, ser. 3, *Mem.*, vol. xii., p. 149.

Protocardia hillana vars. *typica* and *grandis*, Blanckenhorn, Beitrage zur Geologie Syriens, 1890, pp. 89, 90.

Protocardia hillana, Peron, Desc. Mollusques Crétacés, *Explor. Scientif. Tunisie*, 1891, part 2, p. 276.

Cardium hillanum, Jukes-Browne and Hill, Cretaceous Rocks of Britain, Gault, &c., *Mem. Geol. Surv. United Kingdom*, 1900, p. 465.

Protocardia hillana, Quaas, *Palæontographica*, 1902, vol. 30, part 2, fasc. 4, pl. 25, figs. 18–19, p. 218.

Cardium hillanum, Pervinquière: Étude Géologique Tunisie Centrale [Paris] 1903, p. 125.

Protocardium hillanum, Jukes-Browne and Hill. Cretaceous Rocks of Britain, Upper Chalk. *Mem. Geol. Surv. United Kingdom*, 1904, p. 481.

Protocardium hillanum, var. *umkwelanensis*, R. Etheridge, Anderson's "Second Report, Geol. Surv. Natal and Zululand," 1904, pl. 1, fig. 6, p. 79.

Observations.—Four specimens have been referred to this species which, although very imperfect and possessing considerably fractured tests, retain sufficient of the sculpture to enable the present determination to be made with every degree of accuracy. They are quite as large as some of the adult forms occurring at Blackdown, and, like them, are slightly less in height than length. If anything, those from Africa may be rather more coarsely ornamented, but according to Forbes, Stoliczka, and others, examples from European localities cannot be separated from those found in more distant areas such as India, Africa, &c., and that whatever slight variations may exist are more or less common to the shell wherever it is collected.

The shell is characterised by its sub-circular contour, the closely arranged concentric grooves and costæ which ornament the anterior surface of the valve, and the oblique posterior area which bears a dozen or more acute, elevated, longitudinal ribs divided by prominent sulcations. Both the concentric and the longitudinal plications are finest at the umbo, but afterwards become (very gradually, however) more pronounced as they reach the ventral margin. Roughly, the valves show a measurement of about 50 mm. in length, 45 mm. in height, and 15 mm. in diameter, their broken margins preventing a greater accuracy with regard to these dimensions.

The species was originally described from the Blackdown beds of England, where it occurs in large numbers, but it is also found in the succeeding Cenomanian stage of the Cretaceous and in some countries is even recorded as high up as the Senonian.

Distribution.—

England.—Albian (*Ammonites rostratus* zone), and Cenomanian [Jukes-Browne].

France.—Cenomanian and Turonian (Orbigny).

Germany.—Cenomanian (Lower Quader and Lower Planer) Geinitz.

Austria.—Turonian (Gosau Beds), Zittel.

Italy (S.).—Cenomanian (Seguenza).

Syria.—Cenomanian and Senonian (Lartet and Blanckenhorn).
Egypt (Libyan Desert).—Overwegischichten = Danian (Quaas).
Tunis.—Albian and Cenomanian (Peron); Senonian (Pervinquière).
Constantine.—Cenomanian (Coquand).
Natal.—Izinhluzabalungu deposits (Griesbach) = Campanian.
Zululand.—Umkwelane Hill deposit (R. Etheridge, jun).
India (Southern).—Trichinopoly Group (Stoliczka).

Locality.—Tributaries of the Manuan Creek.

FAMILY PHOLADOMYIDÆ.

GENUS PHOLADOMYA, G. B. Sowerby, 1824.

The Genera of Recent and Fossil Shells, 1824, No. xix., pl. 37.

PHOLADOMYA LUYNESI, Lartet.

Plate VI., figs. 1, 2.

Pholadomya luynesi, Lartet, Exploration Géol. de La Mer Morte, &c., 1877, pl. xi., figs. 7, 8, p. 125; Blanckenhorn, Beitr. Geol. Syriens, 1890, p. 95.

Observations.—This is an interesting form of *Pholadomya*, since it differs in possessing a concentric ornamentation without the additional radial striations, so essential a part of the characteristic sculpture of that genus.

The specimen from Zululand, and there is only one, is in a fair state of preservation so far as external characters are concerned, both valves being *in situ* and closed, the posterior end exhibiting a gape. The valves are medianly inflated and furnished with anterior, incurved, contiguous umbones; their contour is elongately oval, with short rounded anterior regions and long posterior areas, whilst the cardinal line is horizontal and sub-parallel with the curved ventral border. The lunule is not distinct, as slight crushing of the valves has taken place beneath the umbones, but in the rear a moderately deep and narrow escutcheon area is present. Fragments of shell structure are still adherent to the specimen, proving it to be extremely thin, the ornamentation showing rugose and finer concentric striations.

Dimensions.—

	Zululand Specimen.	Type Specimen from Holy Land.
Length	34	45 mm.
Height	19	25 „
Diameter	16	25 „

As will be seen from the above measurements, the chief difference between our specimen and Lartet's type from the Holy Land is its smaller size. According to Blanckenhorn, the species is found in Syria in the *Buchiceras* zone of the Cenomanian series, but that the type from the Holy Land belongs to a higher horizon between the Cenomanian and Senonian.

Locality.—Tributaries of the Manuan Creek.

PHOLADOMYA VIGNESI, Lartet *emend.* Blanckenhorn.

Plate VI., figs. 3–6.

Pholadomya vignesi, Lartet, Explor. Géol. de la Mer Morte, 1877, pl. xi., fig. 9, p. 126; Blanckenhorn, Beitrage zur Geologie Syriens, 1890, pl. 5, figs. 14, 16, 17, p. 94.

Cymella (*Pholadomya ?*) *vignesi* (Lartet), Whitfield, *Bull. American Mus. Nat. Hist.*, 1891, vol. 3, p. 386 (quoted in list without explanatory text).

Pholadomya vignesi, Kossmat, *Denkschr. K. Akad. Wiss.*, 1902, vol. 71, pl. 4, fig. 9, p. 55 (Semha Island, near Socotra).

Observations.—From the number of specimens in the collection, this form of *Pholadomya* appears to be a characteristic fossil of Zululand. The valves are mostly in a fair state of preservation, especially as regards external features, the typical granulations of the costæ being well expressed. In longitudinal measurement they vary from 20–35 mm. The full dimensions of two right valves showing these extremes of size, give the following results :—

	Largest.	Smallest.
Length	35	20 mm.
Height	30	17 ,,
Depth	15	8 ,,

The valves are transversely sub-oval, strongly convex or arched, inæquilateral, and having antemedian incurved umbones. Anteriorly the sides are short, rounded, and ventricose, whilst the posterior regions are produced and depressed. The sculpture is made up of closely arranged radial costæ (18–26) and concentric ridges, bearing numerous small rounded granulations, which with age appear to become flattened and more or less transversely elongate. On the extreme anterior side in the neighbourhood of the lunule the radial costæ are very obscure or absent, and they are altogether wanting on the posterior area, which, with the exception of extremely fine concentric lineations, has a nearly smooth surface. The concentric ridges are more accentuated on the umbonal region, the radial sculpture becoming stronger as the shell advances in size. A certain

amount of development has been possible in the hinge area of the smallest right valve, which discloses beneath the umbo a small rounded cavity or fossa in immediate connection with a postero-horizontal groove, which may have originally supported a ligamental nymph. No cardinal teeth are present, so that everything points to this shell being a true *Pholadomya*, and not a *Cymella*, as determined by Mr. Whitfield (without, however, any explanation), which was one of Meek's sub-genera furnished with a central dentition.

Dr. Blanckenhorn has given an excellent account of this species, accompanied by some good illustrations, as it occurs in several Syrian localities, the valves of which are perhaps not so sharply granulated as in the examples from Zululand, but the general structure is the same; that is, the elevated radial costæ are deeply impressed by the crossing of the concentric ridges, thus producing a series of quadrangulations, the raised centres of which represent the tubercles, these being more or less sharply defined according to the degree of preservation of the valve.

There are two or three species with which this *Pholadomya* may be related, although without actual specimens they are difficult to understand; such, for instance, as *P. subdinnensis* of Orbigny (Paléont. Française Terr. Crétacés, Lamellibranchia, 1843, pl. 250, figs. 1–3, p. 38, and Prodrome de Paléontologie, 1850, vol. 2, p. 157), found in the Cenomanian of France, which possesses granulate costæ, but only on the anterior half of the valve, the posterior half appearing to have only plain or smooth costæ. Then, again, Zittel's *P. granulosa* (*Denkschr. K. Akad. Wiss.* [Wien], 1864, vol. 24, pl. 2, fig. 3, p. 116), which, as the name implies, shows a very similar structure, but according to the author the interior of the right valve possesses a wide apophysis beneath the umbones, which is not present in the valves from Zululand. Further, it may be mentioned that Forbes's *Cardium lucerna*, from the Southern Indian Cretaceous, regarded subsequently by Stoliczka as *Pholadomya caudata* of Roemer, the equivalent of *Corbula æquivalvis* of Goldfuss (see Stoliczka, Cretaceous Pelecypoda, Southern India, *Pal. Indica*, 1871, pl. 2, figs. 10, 11, pl. 16, fig. 19, p. 79) from the European (Aachen) Cretaceous, differs in its finer costæ, more rostrate form, and in possessing cardinal teeth. On account of the presence of these teeth Holzapfel has recognised that species under Meek's genus *Liopistha* (*Palæontographica*, 1889, vol. 35, pl. 9, figs. 4–6, pp. 150–151).

According to Blanckenhorn and Lartet, *P. vignesi* has been collected in the Cenomanian of Algeria in company with *Protocardia hillana* and *Hemiaster batnensis*. It is recorded from similarly aged

rocks of Palestine (Jerusalem, &c.) in the *Buchiceras* zone, and it sometimes occurs in the Turonian beds of the same country.

It is interesting to note also that this species has been recognised by Dr. Kossmat in the Upper Cretaceous rocks of the Island of Semha near Socotra (*Denkschr. K. Akad. Wiss.* [Wien], 1902, vol. lxxi., pl. iv., fig. 9, p. 55).

An example of a valve of this species has been recognised as occurring in the form of a natural cavity in the matrix associated with a large form of *Schlœnbachia*, collected by Mr. W. Anderson from the same district in Zululand, the Ammonite being referred to by Mr. G. C. Crick on p. 240 of his memoir upon this subject in Anderson's "Third and Final Report." The condition of the Ammonite, however, was too imperfect for determination, hence it proved of no value for accurate geological horizoning, although the occurrence of *Schlœnbachia* is much in favour of a Cenomanian or Albian age.

Locality.—Tributaries of the Manuan Creek.

Genus GONIOMYA, Agassiz, 1842.

Etudes Critiques sur les Mollusques Fossiles, Monographie des Myes, 1842, p. 1.

Goniomya, sp. 1.

Plate VI., figs. 18, 19.

Observations.—The specimen here referred to is a good fragmentary natural-cast of a somewhat wide form of *Goniomya* which exhibits the anterior and part of the posterior regions of a specimen having united and closed valves. The posterior side of the right umbo is not preserved, otherwise the umbones, judging from the left valve, may be regarded as depressed, incurved, and contiguous, besides being laterally and obtusely carinated; from the front of the umbones a gradually widening gape takes place which extends to the ventral area. A small piece of original shell reposes in the trough-like cavity just behind the umbones, and further fragments are seen elsewhere on the surface, but none retain the granulate ornamentation usually associated with this genus.

As in most forms of *Goniomya*, the valves show compression, their greatest convexity being in the centre of the anterior region. The front margin of the shell slopes considerably from the umbones, and afterwards becomes rounded to meet the curvature of the ventral corner; the ventral borders appear to be crushed and somewhat incomplete. The characteristic V-shaped ribs of this genus can be traced to almost the ventral margins, being arranged with great

regularity on the umbonal region, with the exception of the surface of the incurved part of the umbo, which is much worn and without sculpture, where they are finest and most numerous, the coarsest occurring in the antero-ventral direction where they also become broader and more irregularly disposed; the separating grooves are also widest in the same area.

The coarser costæ take a more or less curved direction before reaching the anterior margin of the valves. Mention should also be made of the presence of a series of similarly broad costæ, which are almost obsolete and quite subsidiary to the **V**-shaped ribs, these being of concentric contour and apparently parallel with the ventral margin.

Dimensions (specimen with united valves).—

Height	41 mm.
Diameter	29 ,,

This specimen appears to show no particular relationship to the few Cretaceous *Goniomyæ* already known in literature. It is of much greater height than the European Cenomanian form originally described by Orbigny as *Pholadomya mailleana* besides having the costal apices vertically arranged from the umbones downwards instead of extending more or less obliquely to the postero-ventral extremity.

A closer affinity may perhaps be traced with *Lysianassa designata* of Goldfuss (Petrefacta Germaniæ, 1840, vol. 2, pl. 154, fig. 13, p. 264) from the Senonian of Bohemia, which, according to the original figure, has a fairly long and oblique anterior margin, a deep umbono-ventral measurement, and a surface sculpture (although only partially shown on account of the specimen being a probably eroded cast), indicating the presence of a series of vertically disposed angulated ribs. The imperfection posteriorly of the specimen from Zululand prevents any estimate of its original length being made, so that further comparison with a form like *designata*, which has a widely elongate posterior region, is of little or no value. Apparently no Cretaceous *Goniomyæ* have been recorded from India, and further they appear to be exceedingly rare in African strata, although M. Alphonse Peron has recorded *G. mailleana* from the Cenomanian of Tunis (Desc. Moll. Foss. Terr. Crétacés Tunisie, *Explor. Scientif. Tunisie,* 1890-1891, pt. 2, p. 327), and Mr. Woods has recently figured and described (*Ann. South African Museum,* 1906, vol. 4, part 7, pl. 37, fig. 9, p. 310) *Goniomya sp.* from the Cretaceous of Pondoland which is of small size and in no way comparable to the fragment now described.

Locality.—Tributaries of the Manuan Creek.

GONIOMYA sp. 2.

Plate VI., figs. 20, 21.

Observations.—This form of *Goniomya* has normal-sized valves standing open from the umbones and chiefly exhibiting posterior characters, the ventral and the major part of the anterior regions not being preserved. Although mostly a cast, fragmentary remains of a delicate thin shell are occasionally apparent, and as they do not show structure it is possible they are mere films which do not represent the actual outer surface of the shell. The valves are only moderately convex having strongly incurved, small, depressed and contiguous umbones, on each side of which an oblique ridge is present which in the posterior direction is very obtuse and circumscribes an elongate and slightly excavated escutcheon area, having in the centre a narrow cavity which probably held the ligament. On account of the valves being open a considerable divergence from the umbones is observable in the small part of the anterior region still preserved, and beneath the umbonal ridges, which in this case are sharply defined, runs a smooth internal sulcation. Compared with other specimens of this genus, the posterior region is rather short and rounded at the margin, the whole contour having been probably more or less cylindrical, moreover the original height might very well have measured 25 mm., whilst the actual posterior length of the specimen from the apices of the angulated ribs is 18 mm. The sculpture consists at the umbones of numerous lateral, straight, divergent costæ united in the ventral direction by horizontal costæ, these latter being afterwards replaced by the ordinary deep V-shaped angulations characteristic of the genus, the apices being in regular vertical arrangement from their commencement. The dorsal ends of the lateral costæ curve upwards at the margin, whilst in the postero-ventral direction these ribs become gradually wider and necessarily fewer in number.

From what can be seen of the contour lines, this specimen is likely to have been a more cylindrical form than that represented by *Goniomya sp.* 1, although its fragmentary nature increases the difficulty of a true comparison. The shortness of the valves posteriorly curiously resembles Jurassic forms such as *G. proboscidea* of Agassiz, from Switzerland, but the sculpture of that species is probably less vertically arranged from the umbones and the later postero-lateral costæ are rather finer and more numerous.

Locality.—Tributaries of the Manuan Creek.

Family PLEUROMYIDÆ.

Genus PLEUROMYA, Agassiz, 1845.

Études Critiques sur les Mollusques Fossiles—Monographie des Myes, 1845, p. 231.

Pleuromya africana, R. Etheridge.

Plate VIII., figs. 1–3.

Myopsis (?) *africana*, R. Etheridge, in W. Anderson, Third Report Geol. Surv. Natal and Zululand, 1907, pl. 1, figs. 9, 10, p. 81.

Observations.—It is interesting to be able to recognise in the present collection a species which has been recently described and figured by Mr. Etheridge from the Umsinene River deposits. This species is represented by nearly a dozen examples in various states of preservation, some being partly testaceous and others casts, but none showing either muscular scar markings or the characters of the hinge. With the exception of a young form with imperfect valves which has a height of 15 mm., the specimens may be said to vary in that measurement from 23 to 30 mm., whilst the type, according to the published figure, exhibits a measurement of 25 mm. in the same direction. A slight variation is noticeable in the general contour of the shell, the antero-ventral end being rather broader in some specimens than in others; in the original the anterior end is said to be "comparatively small." The greatest convexity exists in the antero-median area of the valves, this being succeeded posteriorly by a gradual compression which terminates in a moderately sized gape with rounded margins. One of the specimens (that figured) has the valves partially open anteriorly, but in others they are mostly closed in front.

The anterior end view shows the strongly incurved, approximate umbones, in front of which is a prominently wide and excavated sub-umbonal area more or less circumscribed by an obtuse ridge or carination, which proceeds obliquely from the umbones to the antero-ventral corner of the valves, a corresponding obtuse ridge being present on the posterior side of the umbones forming the boundary to a narrow, lanceolate escutcheon area.

The ornamentation consists of a series of concentric, equally wide, sometimes irregular, depressed ridge-like bands, separated by shallow grooves, which are closer together, narrower, and consequently more numerous at the umbones than elsewhere.

The shell structure is extremely thin and only occasionally preserved, but one specimen showing parts of an excellent outer surface

contains myriads, of microscopically fine granulations arranged in delicate oblique lines radiating from the umbones, and in every way agreeing with a corresponding structure described in the original account.

Dimensions (of a specimen with closed valves).—

Length	46 mm.
Height	30 ,,
Diameter	25 ,,

As stated by Mr. Etheridge this species is nearly allied to *Pholadomya neocomensis* of Leymerie (Mém. Soc. Géol. France, 1842, vol. 5, part 1, pl. 3, fig. 4, p. 3), and *Myopsis unioïdes* of Agassiz (Études Crit. Mollusques Fossiles, 1845, pl. 31, figs. 11, 12, p. 258), from the European Neocomian formation, both of which are closely related forms, being perhaps nearest to *neocomensis* on account of its slightly "donaciform" anterior end—a peculiarity referred to by Orbigny (Pal. Française Terr. Crétacés, Lamellibranchia, 1843, pl. 353, figs. 3–8, p. 329) in describing that species.

It has been generally maintained by authors that Agassiz's genera *Pleuromya* and *Myopsis* are of similar character and should therefore be united under the former name, such a result being first initiated by Terquem in his "Observations sur les *Pleuromya* et les *Myopsis* de M. Agassiz" (*Bull. Soc. Géol. France*, 1853, ser. 2, vol. x, p. 534); in accordance with which *Pleuromya* is used on the present occasion instead of *Myopsis* as adopted by Etheridge.

Locality.—Tributaries of the Manuan Creek.

Family TEREDINIDÆ.

Genus TEREDO, Linnæus, 1758.

Systema Naturæ, 1758, edition x., p. 651.

Teredo sp.

Plate VIII., figs. 4, 5.

Observations.—Small masses of calcareo-siliceous rock full of the tubes of a Teredine mollusc probably belonging to the genus *Teredo* or one of its allied forms, have been sawn through in order to investigate their structure. The sections thus exposed exhibit the tubes both longitudinally and transversely, but only the most obscure traces of the valves themselves can be made out. The tubes appear to vary in diameter from about 6 mm. in the anterior region to 1 mm. at the posterior extremity. They are of somewhat

irregular growth, more or less pyriform anteriorly where the valves would be situated, of nearly equal width during two-thirds of their length, but rapidly narrowing the remaining distance so that the weathered surface of one of the blocks is seen to be crowded with the small posterior ends of these tubes. A fairly thick fibrous wall mostly characterises the tubes, the channel itself being frequently occupied with a light-coloured matriciform material. On one of the external weathered surfaces a natural section through the anterior end of a pair of valves is observable, showing a circular outline with an infilling of calcite measuring 4 mm. in diameter, with an obscure indication of the incurved umbones; this appears to be the only reliable evidence of actual shell-structure, mineralisation and other causes probably accounting for its absence.

Baily (*Quart. Journ. Geol. Soc.*, 1855, vol. xi., p. 462) refers to the occurrence of *Teredina*-tubes in the Cretaceous deposits of the Umzambani River district, South-East Africa, "with indistinct traces of the valves," as well as a group of smaller tubes strongly resembling "*Teredo antenautæ* of the London clay," from the same locality, which he thought might be the younger condition of the previously mentioned *Teredina.* Mr. Henry Woods has quite recently reviewed Baily's specimens (*Annals South African Museum*, 1906, vol. 4, part 7, pl. 37, fig. 8, p. 309), and has decided to regard this so-called *Teredina* as a *Teredo* because the evidence was not complete as to whether the tubes were soldered to the valves or not, the absence of accessory dorsal plates being also remarked upon. Mr. Wood's figure of a left valve from Pondoland drawn from a specimen in the South African Museum, does not assist in the identification of the present remains.

Griesbach also mentions the occurrence of *Teredo* in the plant-beds of the "Izinhluzabalungu" deposits of South-East Africa (*Quart. Journ. Geol. Soc.*, 1871, vol. 27, p. 68), whilst similar tubes have been figured and referred to by Mr. Etheridge, jun., as having been collected by Mr. Anderson in the Umsinene River deposits of Zululand (Anderson, Third Report Geol. Surv. Natal and Zululand, 1907, pl. 5, fig. 13, p. 83). More material is, however, required before it could be distinctly stated that Mr. Anderson's present specimens from the Manuan Creek rocks are related to such forms as have already been reported from this south-eastern area of Africa. Our form appears also to be somewhat closely related to species described by Stoliczka from the Utatur beds of Southern India. .

Locality.—Tributaries of the Manuan Creek.

(D).—CONCLUSIONS.

As a preliminary to discussing the geological age of the Mollusca described in this report, it will be of assistance to list the species under their different localities.

(1) Tributaries of the Manuan Creek.

GASTROPODA.

Gyrodes manuanensis, R. B. Newton.
Architectonica kossmati, R. B. Newton.
Turritella manuanensis, R. B. Newton.
Drepanocheilus sp.
Avellana cf. incrassata, J. Sowerby.

PELECYPODA.

Cucullæa woodsi, R. B. Newton.
Trigonarca ligeriensis, Orbigny.
Trigonarca sp.
Glycymeris griesbachi, R. B. Newton.
Trigonia cricki, R. B. Newton.
Lithophaga manuanensis, R. B. Newton.
Inoceramus choffati, R. B. Newton.
Ostrea zululandiæ, R. B. Newton.
Exogyra conica, J. Sowerby.
Exogyra cf. flabellata, Goldfuss.
Neithea quadricostata, J. Sowerby.
Neithea quinquecostata, J. Sowerby.
Camptonectes cf. curvatus, Geinitz.
Syncyclonema orbicularis, J. Sowerby.
Lima cf. gaultina, H. Woods.
Plicatula andersoni, R. B. Newton.
Veniella forbesiana, Stoliczka.
Veniella etheridgei, R. B. Newton.
Mactra (?) rupert-jonesi, R. B. Newton.
Venus sp.
Meretrix andersoni, R. B. Newton.
Meretrix cf. caperata, J. de C. Sowerby.
Protocardia hillana, J. Sowerby.
Pholadomya luynesi, Lartet.
Pholadomya vignesi, Lartet.
Goniomya sp. 1.
Goniomya sp. 2.
Pleuromya africana, R. Etheridge.
Teredo sp.

(2) North End of False Bay.

GASTROPODA.

Scala zululandiæ, R. B. Newton.
Architectonica africana, R. B. Newton.
Perissoptera sp.

PELECYPODA.

Trigonarca ligeriensis, Orbigny.
Glycymeris griesbachi, R. B. Newton.
Trigonia blanckenhorni, R. B. Newton.
Trigonia cf. scabra, Lamarck.
Gervillia sublanceolata, Orbigny.
Exogyra conica, J. Sowerby.
Exogyra sp.
Plicatula rogersi, R. B. Newton.

(3) Umkwelane Hill.

GASTROPODA.

Semifusus sp.

PELECYPODA.

Cucullæa sp.
Pinna cf. complanata, Stoliczka.
Inoceramus expansus, W. H. Baily.

The few Umkwelane Hill mollusca found in the present collection are interesting as forming additional species for that fauna which has already been most ably described by Mr. R. Etheridge, whilst the presence of Baily's *Inoceramus expansus*, determined on this occasion, serves to confirm the suggestion of Mr. Henry Woods that the Pondoland and the Umkwelane Hill deposits may be alike referred to the Campanian stage of the Senonian period. I am not unmindful of the fact, however, that previously to the publication of Mr. Wood's monograph, M. Lemoine had made the suggestion that a part of the Umkwelane Hill deposits containing *Mortoniceras* and *Anisoceras* should be recognised as of Vraconnian or Cenomanian age, although up to the date of that statement the first-named genus had not been included by Mr. Etheridge as a member of that fauna, and it has only quite recently been determined by Mr. Crick as part of the Anderson collection. (References to this subject are made on p. 4 of the present work.)

Mr. G. C. Crick has proved from a study of the Cephalopoda of the north end of False Bay that the beds of that area are of Cenomanian age, and that they are capable of correlation with the Utatur group of Southern India, with the Cenomanian of Northern Madagascar, and with similarly aged rocks of Europe. Such forms

as *Trigonarca ligeriensis, Trigonia cf. scabra, Exogyra conica*, &c., now described from the same area, materially supports this view as to their true position in the Cretaceous series.

The Manuan Creek fossils are the most numerously represented in Mr. Anderson's collection, there being twenty-nine species of Pelecypods and five Gastropods, many of which are referred to new forms, although the reverse state of things obtains in the Cephalopod group, Mr. Crick having found that the False Bay specimens were much more largely in evidence, whereas only a very few were collected in the Manuan Creek district. This paucity of Cephalopod remains in the Manuan Creek deposits has rendered some difficulties in estimating their true geological age, and it is interesting to quote Mr. Crick's remarks in connection therewith: "The fossils [referring to the Cephalopoda] from the Manuan Creek, being as a rule fragmentary and very imperfectly preserved, do not admit of the precise identification possible with the False Bay specimens; they belong, however, to the same series of beds as the False Bay fossils, but most of them—*i.e.*, those labelled 'South Branch of the Manuan Creek'—most probably represent a somewhat higher horizon (possibly Senonian) than that indicated by those fossils, whilst the few specimens from the 'Middle Tributary of the Manuan Creek' seem to show the existence there of either a lower portion of the beds which are exposed at False Bay or even a slightly lower horizon." *

So far as my examination of Mr. Anderson's fossils is concerned, I am not able to recognise the importance of the locality subdivisions of the Manuan Creek district referred to as "Middle Tributary of the Manuan Creek," "South Branch of the Manuan Creek," or "Crossing Middle Tributary." A few of the specimens, it is true, bear these locality labels, but since they were collected I fear they have got somewhat mixed, and it is far safer now to regard the whole of the fossils from this particular series of deposits as from the "Tributaries of the Manuan Creek," a general locality given me by Mr. Anderson himself a short time before he left London for South Africa.

The Manuan Creek fossiliferous rock is generally a hard, grey-brown calcareous sandstone, although occasionally it is a light reddish-brown matrix of a soft marly character. Both rocks, which sometimes seem to merge into each other, are in all probability parts of the same set of sedimentary beds, and would appear to be those referred to by Mr. Anderson in his description of the rocks of this area (see p. 9 of this work).

* In W. Anderson's "Third and Final Report of the Geological Survey of Natal and Zululand," 1907, p. 249.

DISTRIBUTION TABLE OF THE CRETACEOUS GASTROPODA AND PELECYPODA FROM THE MANUAN CREEK AND FALSE BAY DISTRICTS OF ZULULAND.

Determinations.	Zululand. Manuan Creek.	Zululand. False Bay.	Alliances or the Same Species occurring in India.	Southern India. Utatur Group (Cenomanian to Turonian).	Southern India. Trichinopoly Group (Turonian to Senonian).	Southern India. Ariyalur Group (Upper Senonian).	Alliances or the Same Species from Various Countries, with their Geological Horizons.
GASTROPODA.							
Gyrodes manuanensis, R. B. Newton	×		*Gyrodes pansus*, Stoliczka	×	×	×	*G. euryomphala*, Philippi—Senonian of Quiriquina, Chili, and *G. conradi*, Meek, determined from Colorado (Turonian) by Stanton.
Scala zululandiæ, R. B. Newton		×					*Pyrgiscus gaultinus* and *woodwardi*, J. S. Gardner—British—Albian.
Architectonica africana, R. B. Newton		×					*Solarium pulchellum*, Baily, and *S. wiebeli*, Griesbach—Pondoland—Campanian.
Architectonica kossmati, R. B. Newton							Distantly related to Campanian forms from Umkwelane Hill and Umsinene River, Zululand.
Turritella manuanensis, R. B. Newton	×		*Turritella nodosa*, Rœmer (Stoliczka)	×			*Zaria* (?) *sp.*, R. Etheridge, from Umsinene River deposits of Zululand.
Drepanocheilus, *sp.*	×						*Rostellaria calcarata*, J. Sowerby—British—Albian.
Perissoptera, *sp.*		×					
Avellana cf. *incrassata*, J. Sowerby	×						*Avellana incrassata*, J. Sowerby—Albian-Cenomanian, British, &c.
PELECYPODA.							
Cucullæa woodsi, R. B. Newton	×						*Cucullæa glabra*, Parkinson—Albian—British, &c.
Trigonarca ligeriensis, Orbigny		×					*Trigonarca ligeriensis*, Orbigny—Europe, Syria; Cenomanian.

Trigonarca sp.	×						*Cucullæa rugosa*, Holzapfel—Lower Senonian—Aix-la-Chapelle (= Aachen).
Glycymeris griesbachi, R. B. Newton	×	×	*Pectunculus subauriculatus*, Forbes (Stoliczka)			×	*Pectunculus sublævis*, J. de C. Sowerby—Albian—British.
Trigonia cricki, R. B. Newton	×		*Trigonia tuberculifera*, Stoliczka		×		*Trigonia aliformis*, Parkinson—Albian to Cenomanian—British.
Trigonia blanckenhorni, R. B. Newton		×					*Trigonia carinata*, Agassiz—Neocomian to Aptian—Britain and Europe.
Trigonia cf. *scabra*, Lamarck		×	*Trigonia scabra*, Lamarck (Stoliczka)		×	×	*Trigonia scabra*, Lamarck—Albian to Cenomanian—British and European.
Lithophaga manuanensis, R. B. Newton	×		*Lithodomus subcylindrica*, Stoliczka	×			
Inoceramus choffati, R. B. Newton	×						
Gervillia sublanceolata, Orbigny		×					*Gervillia sublanceolata*, Orbigny—Barremian to Albian—British and European.
Ostrea zululandiæ, R. B. Newton	×						*Ostrea curvirostris*, Nilsson — Campanian — Europe.
Exogyra conica, J. Sowerby	×	×					*Exogyra conica*, J. Sowerby, Albian to Cenomanian—Britain, Europe, N. Africa.
Exogyra, *sp.*		×					*Exogyra sinuata*, J. Sowerby—Barremian to Albian—Britain and Europe.
Exogyra, cf. *flabellata*, Goldfuss	×						*Exogyra flabellata*, Goldfuss—Cenomanian—Europe and Northern African localities.
Neithea quadricostata, J. Sowerby	×		*Neithea quadricostata*, J. Sowerby	×			*Neithea quadricostata*, J. Sowerby—Albian to Cenomanian—Britain, Europe, Syria, Arabia, India, Afghanistan, Madagascar, Brazil.
Neithea quinquecostata, J. Sowerby	×		*Neithea quinquecostata*, J. Sowerby (Stoliczka)	×	×	×	*Neithea quinquecostata*, J. Sowerby—Aptian to Senonian—Europe—British East Africa, Portuguese East Africa—Socotra—Tunis.
Camptonectes cf. *curvatus*, Geinitz	×		*Camptonectes curvatus*, Geinitz (Stoliczka)		×	×	*Camptonectes curvatus*, Geinitz—Senonian—Europe.
Syncyclonema orbicularis, J. Sowerby	×						*Syncyclonema orbicularis*, J. Sowerby—Neocomian to Cenomanian—Britain and Europe.
Lima cf. *gaultina*, H. Woods	×						*Lima gaultina*, H. Woods—Britain—Europe.
Plicatula andersoni, R. B. Newton	×		*Plicatula multicostata*, Forbes (Stoliczka)		×		*Plicatula aspera*, J. de C. Sowerby—Turonian—Gosau.
Plicatula rogersi, R. B. Newton		×					*Plicatula paucicostata*, Seguenza—Cenomanian to Turonian—Italy.
Veniella forbesiana, Stoliczka	×		*Veniella forbesiana*, Stoliczka		×		*Veniella forbesiana*, Stoliczka—Turonian and Senonian of Tunis; Senonian of Angola, South-Western Africa; related forms occur in the Turonian and Senonian of the United States.

DISTRIBUTION TABLE OF THE CRETACEOUS GASTROPODA AND PELECYPODA FROM THE MANUAN CREEK AND FALSE BAY DISTRICTS OF ZULULAND (*Continued*).

Determinations.	Zululand. Manuan Creek.	Zululand. False Bay.	Alliances or the Same Species occurring in India.	Southern India. Utatur Group (Cenomanian to Turonian).	Southern India. Trichinopoly Group (Turonian to Senonian).	Southern India. Ariyalur Group (Upper Senonian).	Alliances or the Same Species from Various Countries, with their Geological Horizons.
PELECYPODA (*continued*).							
Veniella etheridgei, R. B. Newton	×						
Mactra (?) *rupert-jonesi*, R. B. Newton	×						*Mactra valangiensis*, Pictet and Campiche—Neocomian—Switzerland.
Meretrix andersoni, R. B. Newton	×		*Cytherea* (*Callista*) *fabulina*, Stoliczka	×	×		Near to *Venus faba*, and *ovalis*, J. de C. Sowerby—Britain—Albian.
Meretrix cf. *caperata*, J. de C. Sowerby	×						*Venus caperata*, J. de C. Sowerby—Albian—Britain.
Venus, *sp.*	×						
Protocardia hillana, J. Sowerby	×		*Protocardia hillana*, J. Sowerby (Stoliczka)		×		*Protocardia hillana*, J. Sowerby—Albian to Senonian—Britain, Europe, N. and S.E. Africa.
Pholadomya luynesi, Lartet	×						*Pholadomya luynesi*, Lartet—Cenomanian—Syria.
Pholadomya vignesi, Lartet	×						*Pholadomya vignesi*, Lartet—Cenomanian to Turonian—Syria, Socotra, &c.
Goniomya, *sp.* 1	×						
Goniomya, *sp.* 2	×						
Pleuromya africana, R. Etheridge	×						*Myopsis* (?) *africana*, R. Etheridge—Umsinene River deposits of Zululand—Upper Cretaceous.
Teredo, *sp.*	×			×			Related to Utatur forms from Southern India.

The Distribution Table, setting forth the various species of Gastropods and Pelecypods found in the Manuan Creek and False Bay districts of Zululand, will serve to illustrate the actual occurrence of such forms or their alliances in India and other geologically related countries. Regarding only, for the time being, those species from the Manuan Creek we may mention among the Gastropods the occurrence of a new form of *Gyrodes* which is related to *G. pansus* of Stoliczka found in all three divisions of the Indian Cretaceous and which appears to be allied to *G. euryomphala*, Philippi, from the Senonian of Chili and to Meek's *G. conradi* recorded by Stanton from the Turonian of Colorado.

The new species, *Architectonica kossmati*, would appear to be distantly related to a Campanian form described by Mr. Etheridge, from Umkwelane Hill and a form of probably older horizon from the Umsinene River district of Zululand. There is also described a new *Turritella*, showing slight affinities with *T. nodosa* of Rœmer, which Stoliczka has acknowledged as occurring in the Utatur group of Southern India; the new species may also be compared with *Zaria* (?) *sp.* of Etheridge from the Umsinene deposits. Then again the fragmentary example of *Drepanocheilus* exhibits a relationship with *Rostellaria calcarata* of J. Sowerby, a well-known species found in the British Albian, whilst the form of *Avellana* suggests a close connection with James Sowerby's *A. incrassata* belonging to Albian-Cenomanian times. Selecting some of the more striking forms of Pelecypoda, there is the *Cucullæa woodsi* which is related to Parkinson's *C. glabra* of the Albian rocks; *Trigonarca sp.*, a shell related to *Cucullæa rugosa* of Holzapfel from the Emscherian deposits of Germany; *Trigonia cricki*, related to *T. tuberculifera* of Stoliczka found in the Trichinopoly group of India, is undoubtedly closely connected with *T. aliformis* from Albian and Cenomanian deposits; a new form of *Ostrea* (*zululandiæ*) of small size shows certain affinities with Nilsson's *curvirostris* of the European Campanian as well as with a shell from the Cenomanian of Brazil which White has doubtfully recognised as *C. wegmanniana* of Orbigny; *Exogyra conica* of J. Sowerby, occurring as well in the False Bay deposits, ranges from Albian to Cenomanian, and is known from Britain, Europe, and North Africa, but not from India; *Neithea quadricostata* is Albian and Cenomanian, its Indian occurrence being included under *quinquecostata* by Stoliczka, the shell being also known from Afghanistan, Madagascar, Brazil, Syria, Arabia, Europe, and Britain; *Neithea quinquecostata* is more cosmopolitan in its geological distribution, as it occurs in all three divisions of the Indian Cretaceous besides

ranging from the Aptian to Senonian in such countries as Britain, Europe, British and Portuguese East Africa, Socotra and Tunis; *Syncyclonema orbicularis*, ranging from Neocomian to Senonian, is found in Britain and European countries; *Veniella forbesiana* of Stoliczka, a striking shell of the Trichinopoly group of Southern India has also been recorded from the Senonian of Angola in South-Western Africa, and from the Turonian and Senonian of Tunis, Northern Africa, and allied forms are found in the North American Senonian; *Meretrix andersoni*, a new species, is regarded as being related to *Cytherea fabulina* of Stoliczka from the Utatur and Trichinopoly groups of India, as well as to J. de C. Sowerby's shells, *Venus faba* and *V. ovalis* from the British Albian; a form of *Meretrix* allied to *caperata* is also recorded, nothing like it being found in India, whilst the true condition of the species is typical of British Albian deposits; *Protocardia hillana* of J. Sowerby has a range extending from Albian to Senonian times and is known from Britain, Europe, and North and South-East Africa as well as from the Trichinopoly group of India. Lartet's *Pholadomya luynesi*, a peculiar form of the genus without radial striations is only recorded from the Cenomanian of Syria; *Pholadomya vignesi* ranges from Cenomanian to Turonian, having been described by Lartet from Syria, and by Kossmat from Socotra, although unknown in the Indian Cretaceous; lastly, *Pleuromya africana* seems essentially the same as that described by Mr. Etheridge from the Umsinene deposits of Zululand.

From this partial analysis and with the assistance of the Distribution Table it may be readily seen that the Manuan Creek fauna, comprising a total of thirty-four species, contains twelve or thirteen similar or related forms which belong to the Indian Cretaceous. Of these a few are Utatur, a greater number are Trichinopoly, and some are Ariyalur, whilst two of the species range throughout these different groups, of the Upper Cretaceous. Through such a species as *Veniella forbesiana*, a direct connection can be traced between the Trichinopoly group of Southern India, Zululand, and Angola on the south-western portion of Africa, from whence Dr. Paul Choffat records it as occurring in rocks of Senonian age. Related forms, under the generic names of *Roudairia* and *Venilia* are also found in Northern Africa and United States. This, in addition to a few further species, would appear to be in favour of a Senonian horizon for the Manuan Creek fauna, although several of the species bear a distinctly older appearance, such as *Exogyra conica*, *Neithea quadricostata*, *Pholadomya vignesi*, *Avellana incrassata*, &c., some of which extend from Albian into rocks of Cenomanian and Turonian age,

whilst they rarely occur in any of the higher beds of the Upper Cretaceous formation. Taking into consideration, as previously mentioned, that there is no great difference in the lithological character of the matrix accompanying the various specimens from the Manuan Creek, it would seem that we are dealing with a fauna of one geological age which may be regarded as Emscherian, or Lower Senonian, since it includes *Veniella forbesiana*, a characteristic pelecypod of the Upper Trichinopoly beds of Southern India, regarded as Lower Senonian by Dr. Kossmat, which occurs as well in similarly aged rocks of Angola and Tunis, whilst related species of the same genus are also known in the Senonian deposits of the United States.

The False Bay fossils now described appear to support Mr. Crick's contention that their facies agrees with the Utatur* fauna of Southern India, as well as with the Cenomanian of Madagascar and that of Europe.

The new records from the Umkwelane Hill deposits also support the Campanian age for that fauna already recognised by Mr. Woods.

Very few of the shells seem to occur in contiguous areas such as those described by Mr. Etheridge from Umkwelane Hill and the Umsinene River, or those from Pondoland described by Baily, Griesbach, and Mr. Woods. Similar or analogous mollusca are to be met with in Southern India and Madagascar, British and Portuguese East Africa, South-Western Africa (Angola, &c.), Northern Africa, Socotra, Syria, Arabia, Southern European countries, Britain, South America (Brazil), and the United States. This distribution favours Kossmat's view that a connection existed between Southern India and the Atlantic during Upper Cretaceous times—an opinion founded largely upon a study of the Cephalopoda. One of the most important Ammonites in proof of this during Cenomanian or Vraconnian times is *Schlœnbachia inflata* of James Sowerby, *sp.*, the geographical range of which, or allied forms, extends from Southern India through Madagascar to Angola (Choffat) and the Elobi Islands (Szajnocha) on the south-west coastal area of Africa, North Africa (Tunis), Europe, and Brazil (Sergipe); the species, however, is not known from Zululand or any of the immediately adjacent provinces of South-East Africa. Equally important species could be quoted

* Dr. Kossmat has given the following equivalents for this group :—

Upper Utatur = Lower Turonian.
Middle Utatur = Upper and Middle Cenomanian.
Lower Utatur = Lower Cenomanian (Vraconnian).

(*Records Geol. Surv. India*, 1895, vol. 28, p. 40.)

to show that the Turonian and Senonian Cephalopoda offer similar evidence of geographical distribution over the same regions to the eastern Cretaceous developments of the two Americas, but for a further knowledge of this interesting subject the student is referred to Dr. Kossmat's paper on "The Cretaceous Rocks of Southern India," published in the *Records Geological Survey India*, 1895, vol. 28, pt. 2, pp. 40–55.

(E).—MISCELLANEOUS UPPER CRETACEOUS FOSSILS FROM ZULULAND.

VERTEBRATA.

Reptilian-bone.—An indeterminable silicified fragment of reptilian-bone showing transverse and longitudinal sections of the structure. This specimen was kindly examined and referred to the Reptilian group by Dr. C. W. Andrews, F.R.S.

Locality. North end of False Bay.

INVERTEBRATA.

CEPHALOPODA.

Baculites.—Closely resembling *B. bailyi* of H. Woods (*Ann. South African Museum,* 1906, vol. 4, pl. 44, fig. 5, p. 341) from the Campanian rocks of Pondoland, a species which includes *B. sulcatus* (pars) of W. H. Baily from the same beds (*Quart. Journ. Geol. Soc.*, 1855, vol. xi., pl. xi., figs. 5*a* and 5*b* [*non* 5*c*] p. 457).

This specimen is in the matrix containing *Inoceramus expansus, Cucullæa sp.*, and *Semifusus sp.* (see pp. 29, 33, 48).

Locality. Umkwelanè Hill.

POLYZOA.

Membranipora.—An adherent form of this genus is present on the left valve of *Veniella etheridgei* (see p. 71).

Locality. Tributaries of the Manuan Creek.

ANNELIDA.

Serpula.—With resemblances to *S. pinchiniana* (Tate) var. *umsinenensis*, R. Etheridge, from the Umsinene River beds of Zululand (Anderson's "Third and Final Report Geol. Surv. Natal

and Zululand," 1907, pl. 1, figs. 1–6, p. 68), and also to an undetermined form from the Gault and Blackdown beds of England (= Albian); (see p. 62).

This specimen accompanies *Syncyclonema orbicularis.*

Locality. Tributaries of the Manuan Creek.

SERPULA.—Small adherent Annelids (see p. 71) resembling *Vermetus rotula* of Morton from the Upper Cretaceous deposits of New Jersey, United States (Synopsis of the Organic Remains of the Cretaceous Group, United States, 1834, pl. 1, fig. 14, p. 81).

Accompanying *Veniella etheridgei* and found on the lateral surface of the natural cast of the right valve.

Locality. Tributaries of the Manuan Creek.

ACTINOZOA (Corals).

TROCHOCYATHUS.—Several small examples of this genus are in the collection, and from what can be seen of their calycular characters they are probably related to *T. conulus*, Michelin, from the Albian deposits of Britain and the Continent (see Edwards and Haime, British Fossil Corals, *Mon. Pal. Soc.*, 1850, pl. xi., fig. 5, p. 63).

Locality. North end of False Bay.

SPONGIÆ (?).

[Indeterminablé].—A cylindrical stem-like fossil slightly suggestive of relationship to a lithisted sponge.

Locality. North end of False Bay.

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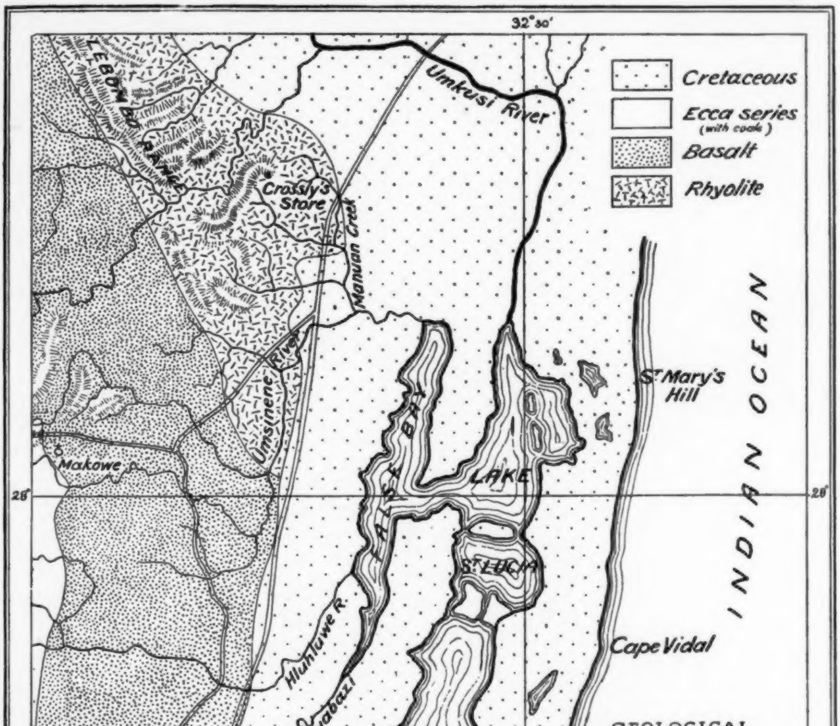
(G).—EXPLANATION OF THE PLATES.

PLATE I.

Geological sketch-map of part of Zululand, after **William Anderson,** F.G.S., designed by Mr. G. C. Crick, F.G.S.



MAP OF ZULULAND.

Plate II.

Ostrea zululandiæ, R. B. Newton (p. 50).

Loc. Tributaries of the Manuan Creek.

Fig. 1. External view of lower valve.
,, 2. Interior of same specimen.
,, 3. Inner aspect of a larger lower valve.
,, 4. Outer view of another lower valve.
,, 5. Internal natural cast of an upper valve, showing lateral denticles.

Exogyra cf. flabellata, Goldfuss (p. 54).

Loc. Tributaries of the Manuan Creek.

Fig. 6. External view of specimen, showing the plicated lower valve.
,, 7. External view of same specimen, showing the somewhat smaller and rather operculiform upper valve.

Exogyra conica, J. Sowerby, sp. (p. 51).

Loc. Tributaries of the Manuan Creek.

Fig. 8. External view of lower valve.

Loc. North end of False Bay.

Fig. 9. External view of lower valve.
,, 10. Inner view of same specimen, showing obscure lateral denticles.

Exogyra, sp. (p. 53).

Loc. North end of False Bay.

Fig. 11. External aspect of an upper valve.
,, 12. The same specimen, exhibiting the inner surface.

Plicatula rogersi, R. B. Newton (p. 66).

Loc. North end of False Bay.

Fig. 13. External view of valve, showing obscure radial costæ.
,, 14. Interior of same specimen, showing muscular scar impression and distant supramarginal tubercles.

Plicatula andersoni, R. B. Newton (p. 64).

Loc. Tributaries of the Manuan Creek.

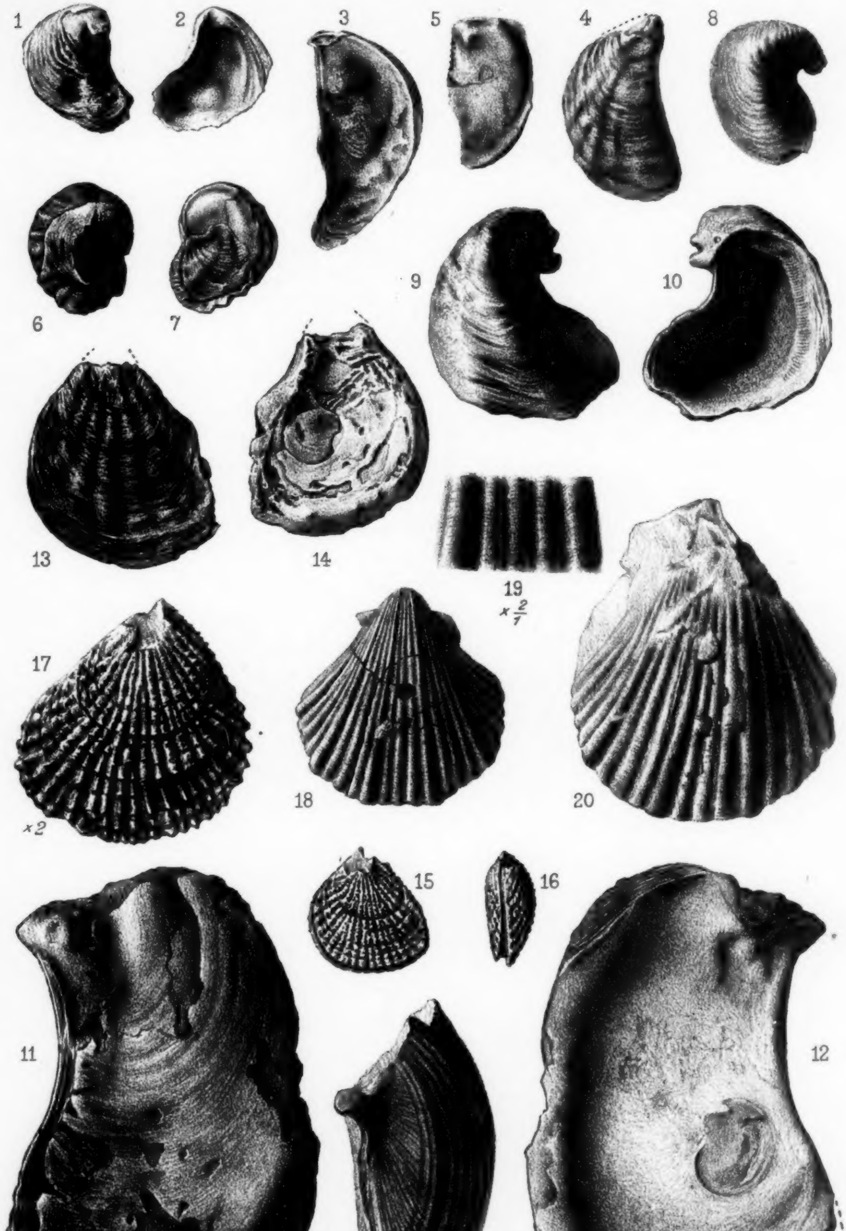
Fig. 15. View of specimen, exhibiting the upper valve.
,, 16. Posterior end aspect of same specimen.
,, 17. External view of same specimen, showing the lower valve. × 2.

Neithea quadricostata, J. Sowerby, sp. (p. 55).

Loc. Tributaries of the Manuan Creek.

Fig. 18. External view of a medium-sized example.
,, 19. Portion of same specimen, showing costal structure. × 2.
,, 20. An adult form, showing exterior.
,, 21. Posterior view of a larger specimen with both valves closed, exhibiting the prominent area with a pair of fine costæ following the thick marginal rib.

[Unless otherwise notified, the figures of the fossils are drawn of the natural size.]



A. H. Searle del. et lith. West, Newman imp.

CRETACEOUS PELECYPODA FROM ZULULAND.

Plate III.

NEITHEA QUINQUECOSTATA, J. Sowerby, sp. (p. 58).

Loc. Tributaries of the Manuan Creek.

FIG. 1. External view of lower valve.
,, 2. Portion of same specimen, showing costal characters. × 2.

SYNCYCLONEMA ORBICULARIS, J. Sowerby, sp. (p. 61).

Loc. Tributaries of the Manuan Creek.

FIG. 3. Outer aspect of specimen, consisting of a left valve.
,, 4. Dorsal end of same, showing the aliform extensions and the close annulated ornamentation, magnified.

CAMPTONECTES cf. CURVATUS, Geinitz sp. (p. 60).

Loc. Tributaries of the Manuan Creek.

FIG. 5. External view of specimen, showing colour bands. × 1½.
,, 6. Surface sculpture of same. × 3.

GERVILLIA SUBLANCEOLATA, Orbigny sp. (p. 48).

Loc. North end of False Bay.

FIG. 7. External view of right valve.
,, 8. External view of left valve.
,, 9. Internal view of left valve, showing the ligament cavities.
,, 10. External aspect of a median portion of a left valve.

INOCERAMUS CHOFFATI, R. B. Newton (p. 45).

Loc. Tributaries of the Manuan Creek.

FIG. 11. External view of right valve.
,, 12. Dorsal view of same, showing convexity of umbonal region.

GLYCYMERIS GRIESBACHI, R. B. Newton (p. 36).

Loc. North end of False Bay.

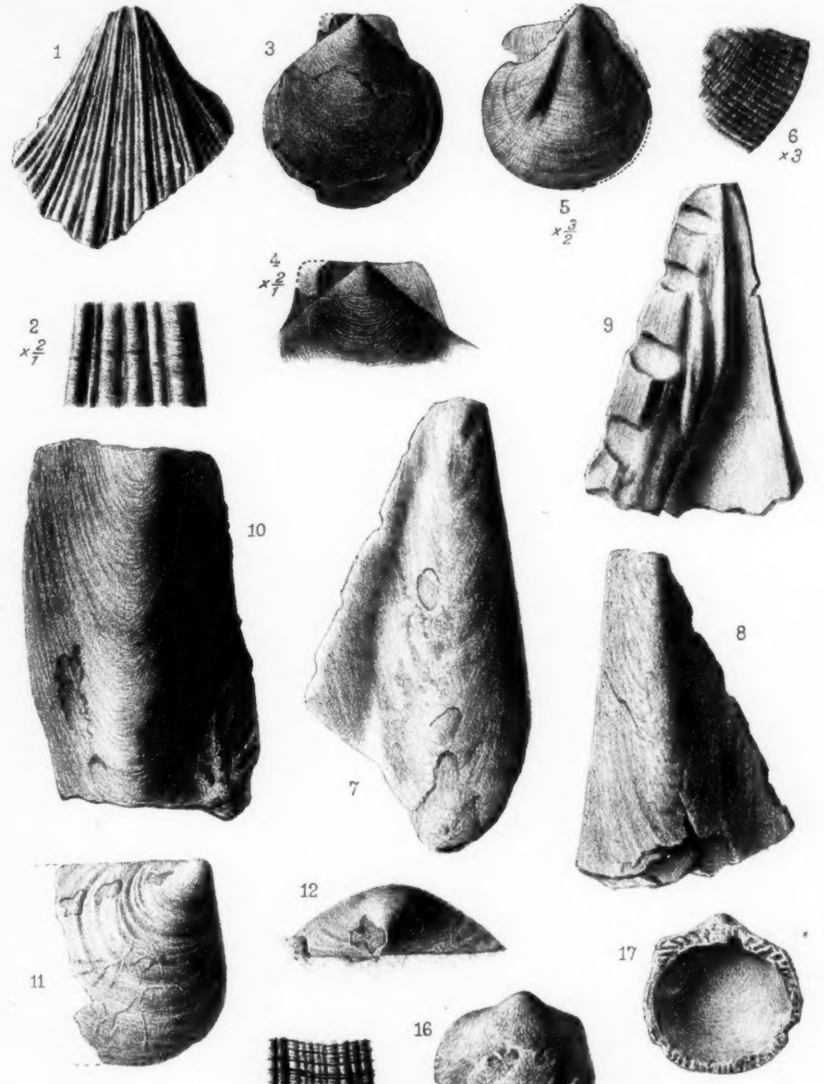
FIG. 13. External view of an adult valve.
,, 14. Interior of same specimen, showing denticulated margin and teeth.
,, 15. Surface structure of same specimen. × 9.
,, 16. External aspect of a smaller valve.
,, 17. Inner view of same.

LIMA cf. GAULTINA, H. Woods (p. 63).

Loc. Tributaries of the Manuan Creek.

FIG. 18. Lateral view of left valve.
,, 19. Posterior side view of the same specimen.

[Unless otherwise notified, the figures of the fossils are drawn of the natural size.]



A. H. Searle del. et lith. West, Newman imp.

CRETACEOUS PELECYPODA FROM ZULULAND.

Plate IV.

Lithophaga manuanensis, R. B. Newton (p. 43).

Loc. Tributaries of the Manuan Creek.

Fig. 1. Lateral view of specimen, showing right valve.
,, 2. Dorsal view of same, showing the closed valves.
,, 3. Anterior end view of same specimen, showing the contiguous umbones.

Cucullæa woodsi, R. B. Newton (p. 31).

Loc. Tributaries of the Manuan Creek.

Fig. 4. Internal view of left valve.
,, 5. External view of same.
,, 6. Hinge view of the right valve of another specimen.
,, 7. Posterior aspect of a small example with both valves united, showing a circumscribed escutcheon area.
,, 8. Dorsal view of same.
,, 9. Surface structure taken from same specimen, magnified.

Trigonarca, sp. (p. 35).

Loc. Tributaries of the Manuan Creek.

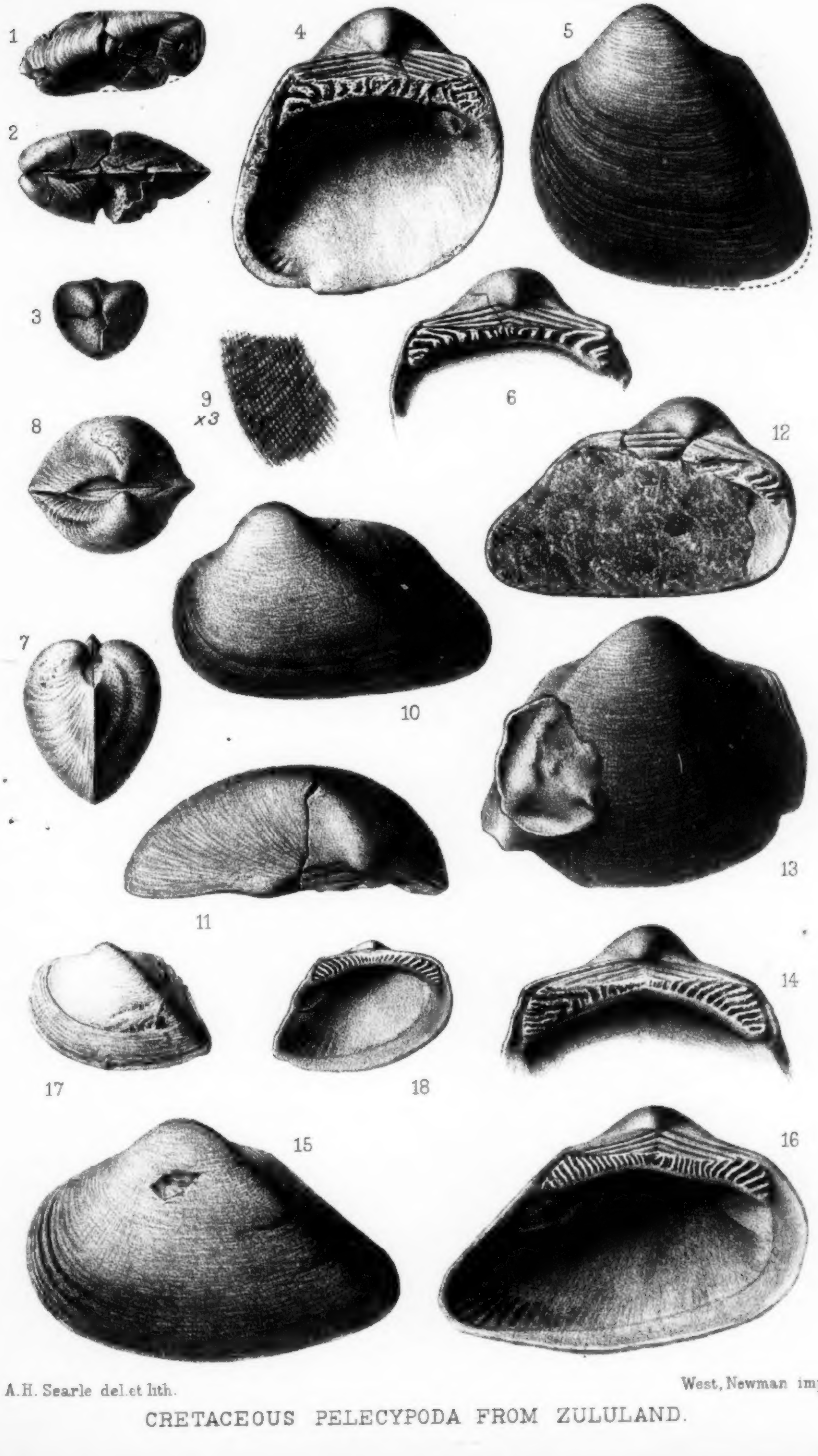
Fig. 10. External view of a left valve.
,, 11. Dorsal view of same, showing area, &c.
,, 12. Interior of same, showing dentition and ligamental grooves.

Trigonarca ligeriensis, Orbigny, sp. (p. 33).

Loc. North end of False Bay.

Fig. 13. External aspect of a large fragmentary example with a small Ostræiform valve attached to its surface.
,, 14. Hinge view of same, showing coarse dentition.
,, 15. External view of a medium-sized example.
,, 16. Inner view of same, showing radial sriations in the ventral region.
,, 17. Exterior of small form.
,, 18. Inner view of same specimen.

[Unless otherwise notified the figures of the fossils are drawn of the natural size.]



A.H. Searle del. et lith. West, Newman imp.

CRETACEOUS PELECYPODA FROM ZULULAND.

Plate V.

Trigonia blanckenhorni, R. B. Newton (p. 40).

Loc. North end of False Bay.

Fig. 1. External view of specimen consisting of a right valve, showing the rounded and equidistant costæ.
,, 2. Posterior view of same, showing the transversely striated teeth, escutcheon, &c.
,, 3. Anterior end view of same specimen, showing the abrupt, smooth margin with the distant upwardly curved elevated ends of the costæ.
,, 4. Inner aspect of same valve, showing the very elongate posterior tooth and the shorter anterior tooth, the pallial line, muscular scars, &c.

Trigonia cf. scabra, Lamarck (p. 42).

Loc. North end of False Bay.

Fig. 5. External view of right valve.
,, 6. Anterior end of same.
,, 7. Dorsal view of same, showing the umbonal convexity and details of the posterior region.
,, 8. External view of a fragmentary left valve of another specimen.
,, 9. Sculpture details of the escutcheon area of the same specimen. × 2.

Trigonia cricki, R. B. Newton (p. 38).

Loc. Tributaries of the Manuan Creek.

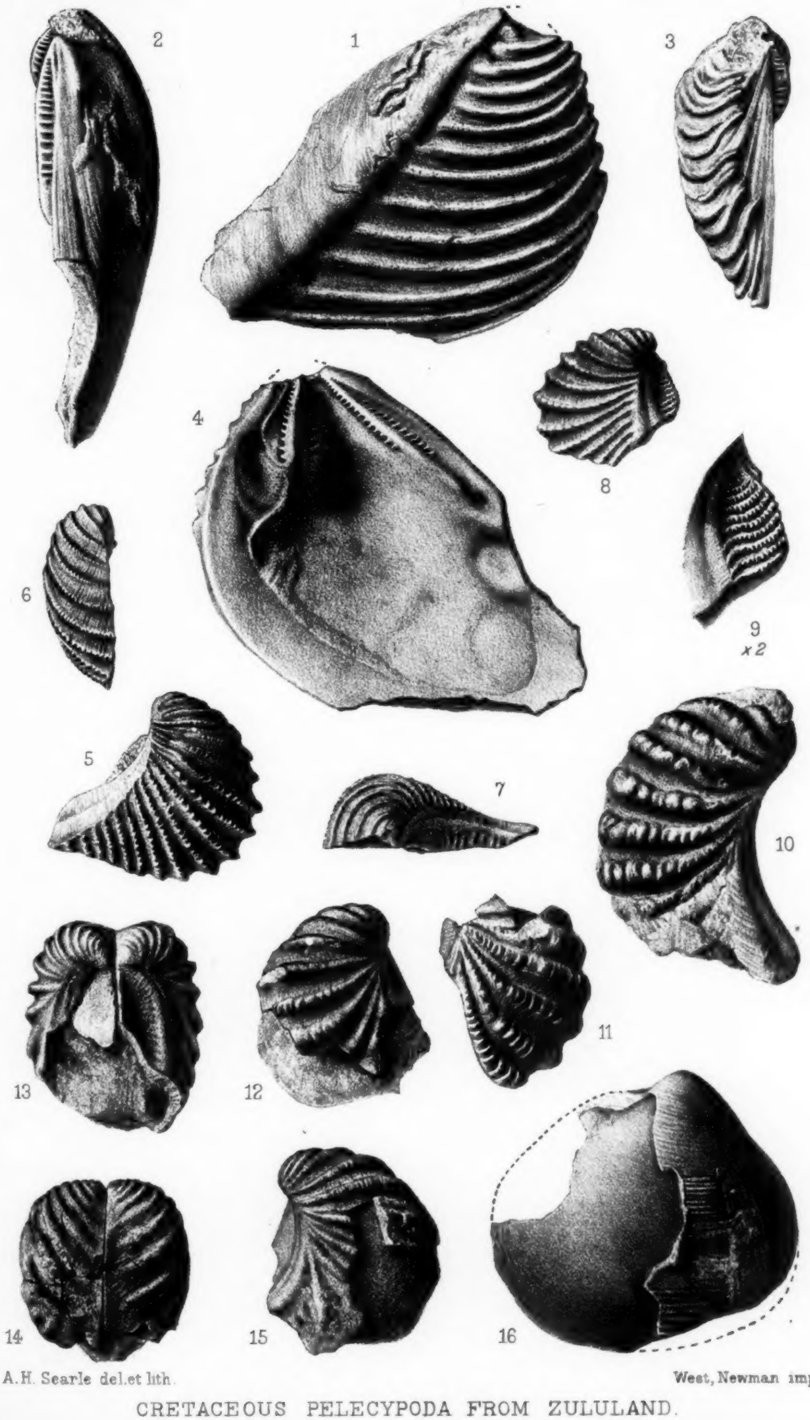
Fig. 10. External view of a left valve, showing the annulated character of the costæ.
,, 11. External view of a fragmentary right valve, showing the characteristic costæ.
,, 12. External view of specimen, showing the left valve.
,, 13. Escutcheon view of same specimen, showing both valves united.
,, 14. Anterior end view of the same, showing inclination of the costæ.
,, 15. Right lateral aspect of the same example.

Protocárdia hillana, J. Sowerby (p. 76).

Loc. Tributaries of the Manuan Creek.

Fig. 16. External aspect of an imperfect left valve, showing the costated posterior region and the concentrically ornamented anterior portion of the shell.

[Unless otherwise notified, the figures of the fossils are drawn of the natural size.]



A. H. Searle del. et lith. West, Newman imp.

CRETACEOUS PELECYPODA FROM ZULULAND.

Plate VI.

Pholadomya luynesi, Lartet (p. 78).

Loc. Tributaries of the Manuan Creek.

Fig. 1. Left lateral view of specimen.
,, 2. Dorsal view of same, showing the contiguous umbones and the posterior gape.

Pholadomya vignesi, Lartet (p. 79).

Loc. Tributaries of the Manuan Creek.

Fig. 3. External view of an adult right valve.
,, 4. Interior of a young right valve.
,, 5. Dorsal view of same specimen, showing the arched umbonal region and the sub-trigonal fossa beneath the umbo, succeeded by a narrow, horizontal posterior groove ; no dentition is present as in *Liopistha*.
,, 6. External view of the same specimen.

Meretrix andersoni, R. B. Newton (p. 75).

Loc. Tributaries of the Manuan Creek.

Fig. 7. External aspect of a left valve.
,, 8. Left lateral aspect of a smaller specimen, with united valves.
,, 9. Dorsal view of same.

Venus sp. (p. 73).

Loc. Tributaries of the Manuan Creek.

Fig. 10. External left lateral aspect of specimen, showing the posterior area as a matriciform cast.
,, 11. Front view of same, showing the well-inscribed lunule.
,, 12. Posterior end view of same as an internal cast denuded of test.

Meretrix cf. caperata, J. de C. Sowerby, sp. (p. 74).

Loc. Tributaries of the Manuan Creek.

Fig. 13. External left lateral aspect of specimen.
,, 14. Dorsal view of same, showing lunule, escutcheon, and mineralised ligament.
,, 15. Sculpture details. × 6.

Mactra (?) rupert-jonesi, R. B. Newton (p. 71).

Loc. Tributaries of the Manuan Creek.

Fig. 16. Left lateral aspect of specimen, showing parts of both valves.
,, 17. Dorsal view of same, and the much-fractured umbonal region.

Goniomya sp. 1 (p. 81).

Loc. Tributaries of the Manuan Creek.

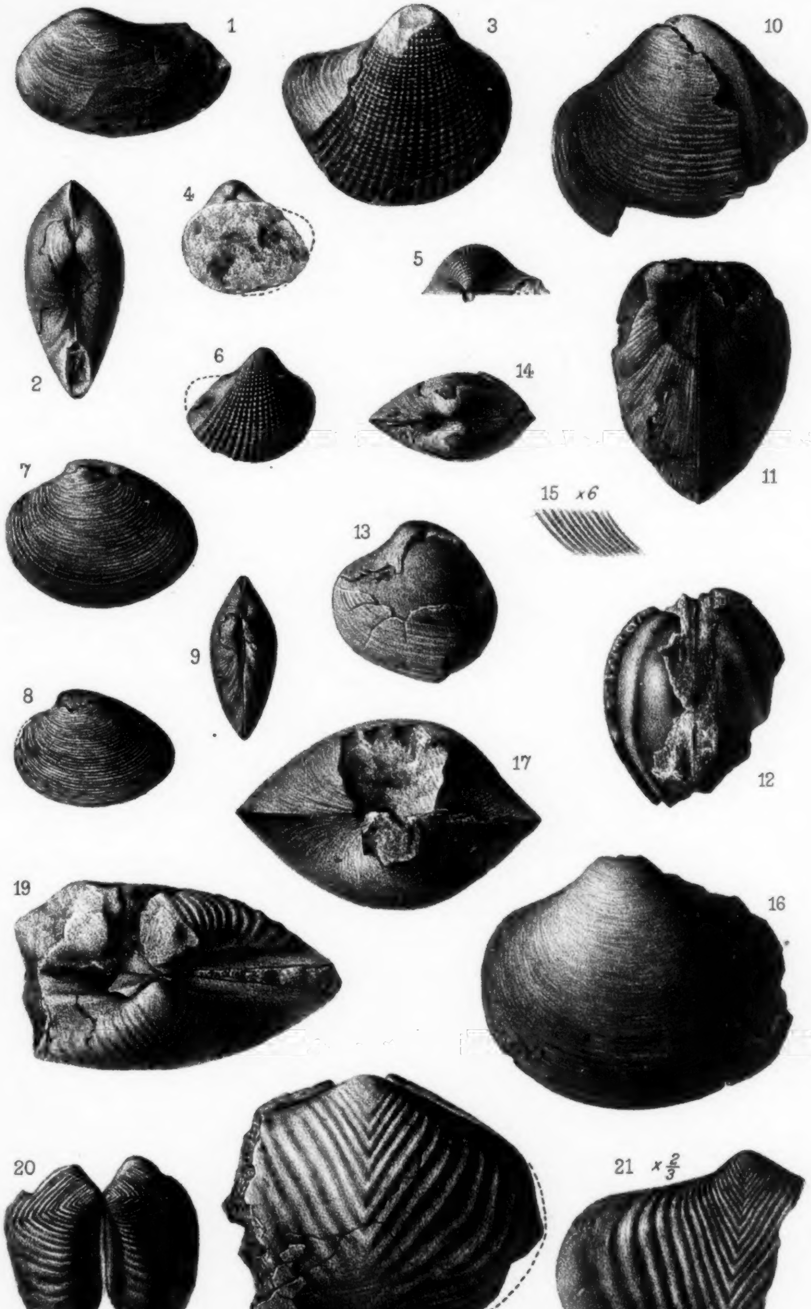
Fig. 18. Left lateral view of specimen, with parts of both valves.
,, 19. Dorsal aspect of same, showing the slightly open valves in the anterior region.

Goniomya sp. 2 (p. 83).

Loc. Tributaries of the Manuan Creek.

Fig. 20. Dorso-umbonal view of specimen embedded in matrix, showing both valves extended.
,, 21. Enlarged right lateral view of same, showing the closely fitting costæ. × $\frac{3}{2}$.

[Unless otherwise notified, the figures of the fossils are drawn of the natural size.]



A. H. Searle del. et lith. West, Newman imp.

CRETACEOUS PELECYPODA FROM ZULULAND.

PLATE VII.

VENIELLA FORBESIANA, Stoliczka, sp. (p. 67).

Loc. Tributaries of the Manuan Creek.

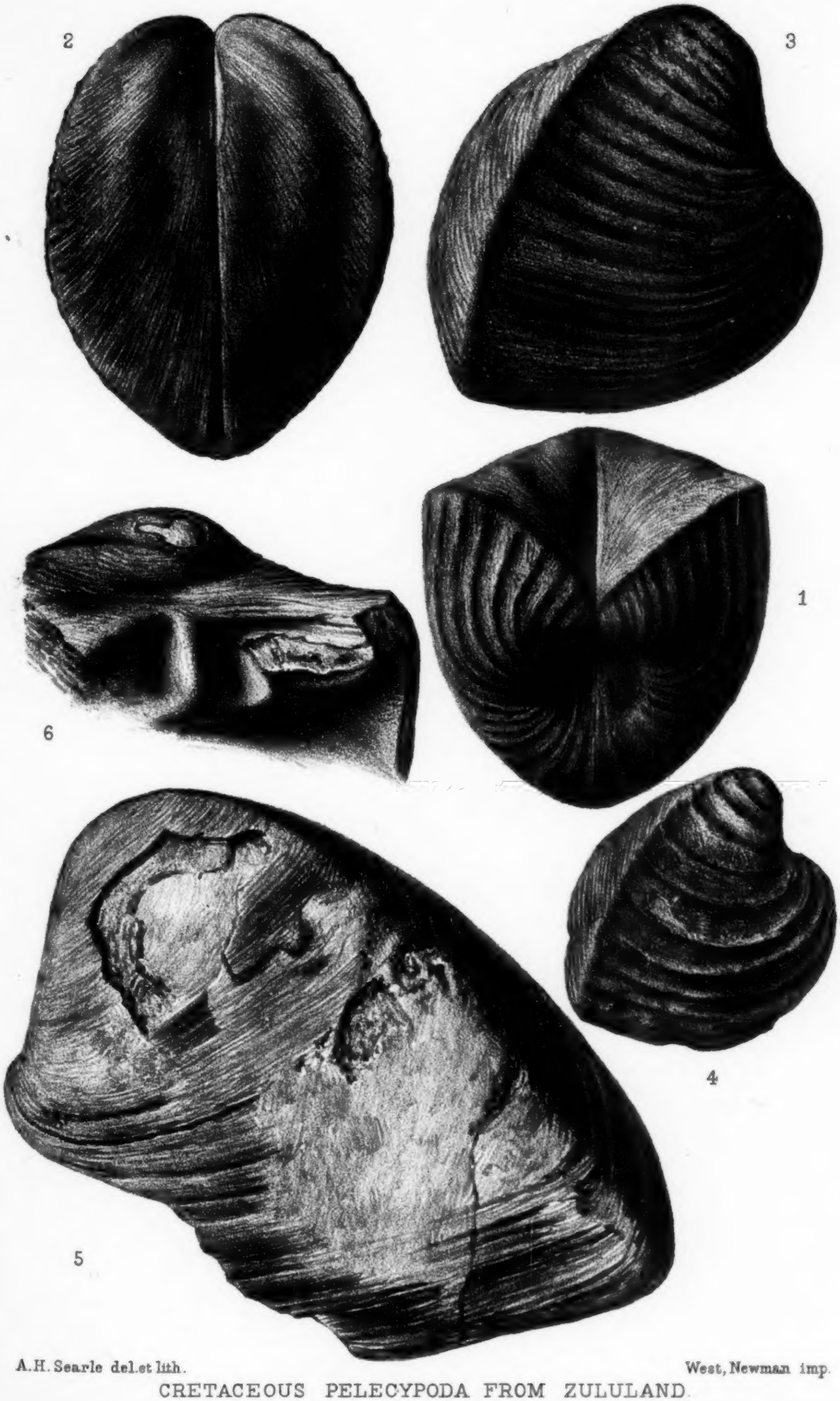
FIG. 1. Dorsal view of an adult example, showing lunule, escutcheon, &c.
,, 2. Posterior view of same, showing the narrow escutcheon and the wide areal region.
,, 3. Right lateral view of same.
,, 4. A right valve of a smaller example.

VENIELLA ETHERIDGEI, R. B. Newton (p. 69).

Loc. Tributaries of the Manuan Creek.

FIG. 5. Left lateral view of specimen, containing parts of both valves.
,, 6. Hinge details of the same, showing the massive dentition.

[Unless otherwise notified, the figures of the fossils are drawn of the natural size.]



A.H. Searle del. et lith. West, Newman imp.

CRETACEOUS PELECYPODA FROM ZULULAND.

Plate VIII.

Pleuromya africana, R. Etheridge, sp. (p. 84).

Loc. Tributaries of the Manuan Creek.

Fig. 1. Left lateral view of specimen.
,, 2. Dorsal aspect of same.
,, 3. Granulate structure of test. × 10.

Teredo sp. (p. 85).

Loc. Tributaries of the Manuan Creek.

Fig. 4. Section of rock largely composed of this organism.
,, 5. Vertical section through a pair of valves exposed on the weathered surface of another rock mass, showing the incurved umbones. × 2.

Avellana cf. incrassata, J. Sowerby, sp. (p. 30).

Loc. Tributaries of the Manuan Creek.

Fig. 6. Front view of specimen, showing two folds on the columella.
,, 7. Dorsal view of same.
,, 8. Surface structure, showing the vertical striations within the concentric costæ. × 5.

Gyrodes manuanensis, R. B. Newton (p. 18).

Loc. Tributaries of the Manuan Creek.

Fig. 9. Dorsal view, showing the posteriorly flattened and excavated suture and obscurely nodulated margin.
,, 10. Umbilical aspect of same.

Architectonica kossmati, R. B. Newton (p. 23).

Loc. Tributaries of the Manuan Creek.

Fig. 11. Dorsal view showing partial testiferous structure. × 2.
,, 12. Umbilical aspect of same specimen. × 2.

Architectonica africana, R. B. Newton (p. 22).

Loc. North end of False Bay.

Fig. 13. Dorsal view of specimen. × 2.
,, 14. Basal aspect of same specimen, showing the narrow umbilicus. × 2
,, 15. External surface structure of whorls, as seen in another example. × 6.

Turritella manuanensis, R. B. Newton (p. 25).

Loc. Tributaries of the Manuan Creek.

Fig. 16. Dorsal view of specimen wanting the earlier volutions.
,, 17. Penultimate whorl of same, showing details of the ornamentation. × 3.

Scala zululandiæ, R. B. Newton (p. 20).

Loc. North end of False Bay.

Fig. 18. Dorsal aspect of specimen, fractured in the basal region.
,, 19. Sculpture details of the whorls, showing the posterior bevelled margin. × 3.

Perissoptera sp. (p 27).

Loc. North end of False Bay.

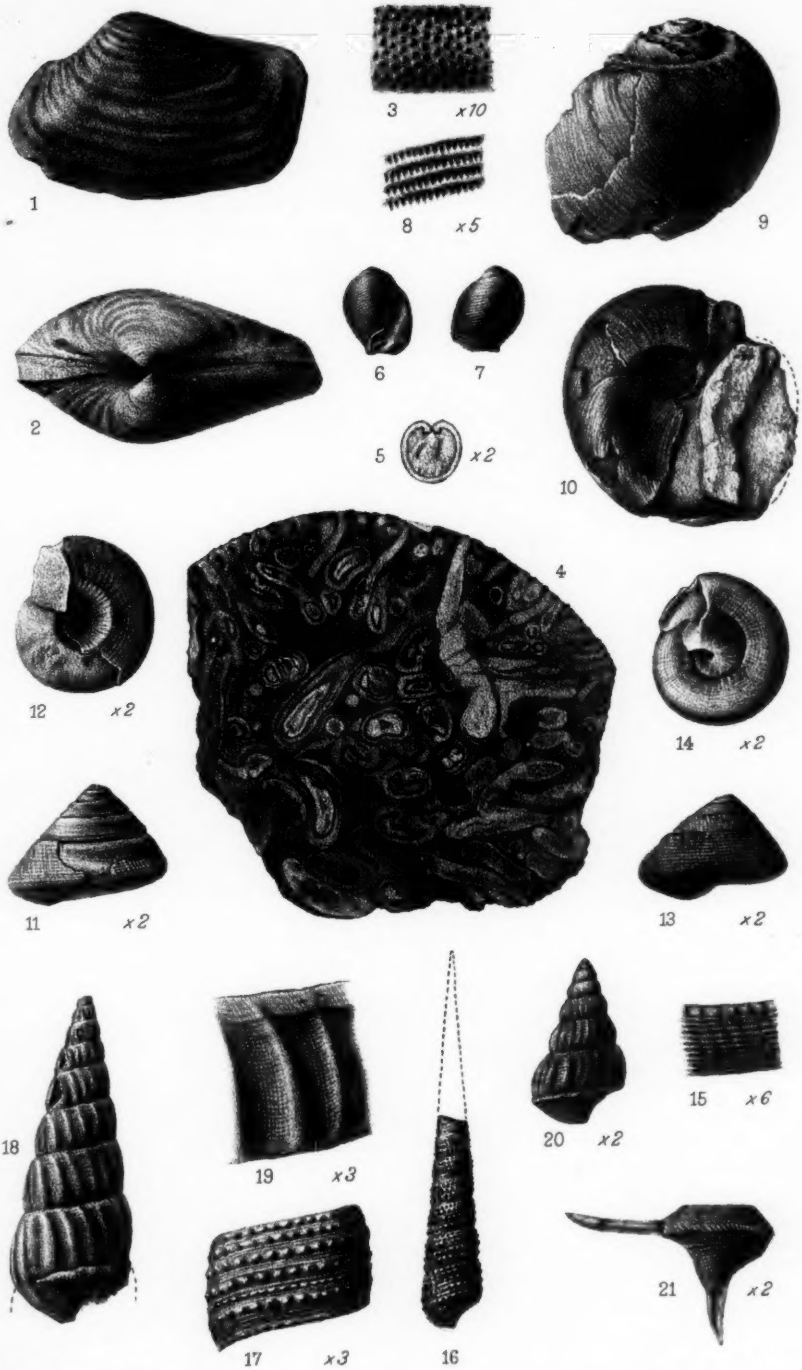
Fig. 20. Dorsal view of specimen. × 2.

Drepanocheilus sp. (p. 26).

Loc. Tributaries of the Manuan Creek.

Fig. 21. Dorsal view of specimen of which the basal whorl only is preserved; it occurs as a cavity in the matrix, the figure being drawn from a wax squeeze of the same. × 2.

[Unless otherwise notified, the figures of the fossils are drawn of the natural size.]



A. H. Searle del. et lith. West, Newman imp.

CRETACEOUS PELECYPODA & GASTROPODA FROM ZULULAND.

Plate IX.

Inocreamus expansus, Baily (p. 47).

Loc. Umkwelane Hill.

Fig. 1. View of fragmentary specimen, representing a right valve which has been drawn from the plaster cast of a matrix concavity. $\times \frac{2}{3}$.

,, 2. Detached portion of same specimen, showing the prominent umbo of this species as a convex natural cast; obscure radial striations are seen at the summit, which are probably of vascular origin.

Pinna cf. complanata, Stoliczka (p. 44).

Loc. Umkwelane Hill.

Fig. 3. Lateral view showing shell structure in places, the concave ventral margin, and the straight dorsal line.

,, 4. Basal section of same, showing convexity of valves and lateral notches, caused by longitudinal fracture of the valves.

Cucullæa, sp. (p. 32).

Loc. Umkwelane Hill.

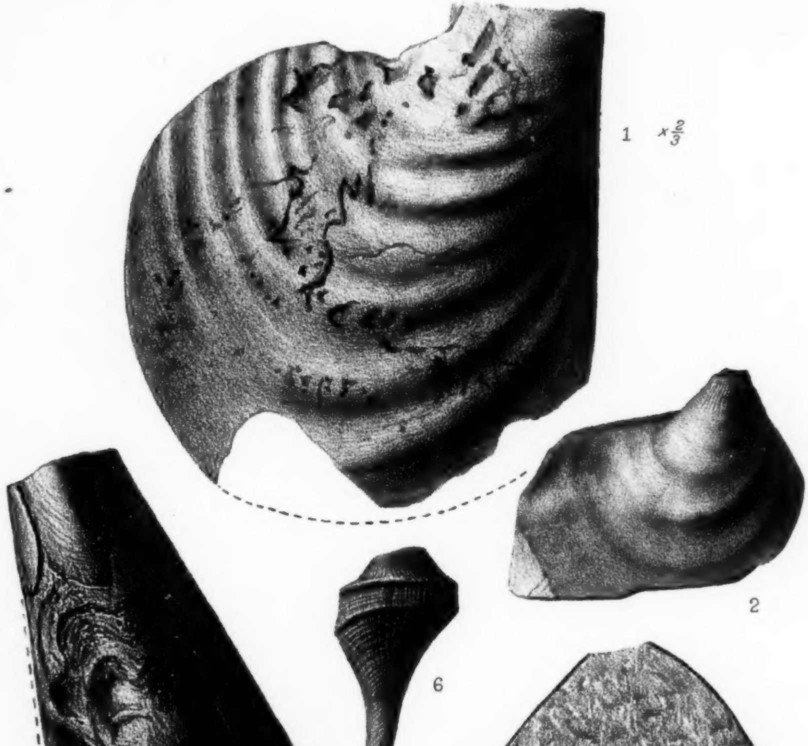
Fig. 5. External aspect of specimen, consisting of a right valve showing obscure testiferous structure. $\times \frac{2}{3}$.

Semifusus (?) (p. 28).

Loc. Umkwelane Hill.

Fig. 6. Dorsal view of specimen, which is wanting the spire, showing the bicarinated body-whorl and the narrowly elongate anterior prolongation. This specimen occurs in a rock cavity, the figure having been drawn from a wax cast of the same.

[Unless otherwise notified, the figures of the fossils are drawn of the natural size.]



A.H. Searle del. et lith.

West, Newman imp.

CRETACEOUS PELECYPODA & GASTROPODA FROM ZULULAND.

A NEW VARIETY OF *IXODES PILOSUS* (Koch).

By J. G. Neumann
(Professor à l'École vétérinaire de Toulouse).

(Read June 17, 1908.)

Ixodes pilosus howardi, n. subsp.

Male.—Semblable au type spécifique, mais un peu plus petit; 2 mm. 3, de longueur sur 1 mm. 2 de largeur, au lieu de 3 mm. 15 sur 1 mm. 6.

Femelle.—Diffère du type spécifique par les caractères suivants:—

Ecusson dorsal plus long (1 mm. 27) que large (1 mm. 1), ovale; sillons cervicaux et latéraux moins marqués; ponctuations plus fines, moins profondes, plus nombreuses, Poils moins abondants sur les faces dorsale et ventrale. Sillon anal a branches plus rapprochées et formant une ellipse ouverte en arrière. Rostre plus faible, long de 0 mm. 7 (au lieu de 0 mm. 85 dans le type spécifique); aires poreuses plus petites, moins profondes, plus écartées. Pattes bien plus faibles, surtout dans les hanches. Couleur générale (á jeun) rouge orangé.

D'aprés 2 males et 12 femelles recueillis sur le Chien á Leydsdorp (Transvaal), et á Durban (Natal), par C. W. Howard (de Prétoria).

A NOTE ON THE DISTRIBUTION AND HOSTS OF *IXODES PILOSUS HOWARDI*, Neum.

By C. W. Howard, Pretoria.

(Read June 17, 1908.)

In the preceding article Professor Neumann has described a new tick from the Transvaal. Some notes on its distribution and hosts may be of interest to those making a study of this group.

The first specimens were sent to me by Dr. Copland, the District Surgeon at Leydsdorp; at about the same time Dr. Theiler brought specimens from Durban. It was from these specimens that Professor Neumann described the variety. Since that time I have taken specimens from the following places in the Transvaal: Lenokana Location, Marico District; Pilansberg Mountains, Rustenburg District; Pienaars River, Pretoria District; Ivy Mine, Moodies, Barberton District; and the Zoutpansberg Mountains in the Zoutpansberg District.

Mr. Lounsbury, in one of his reports, states that *I. pilosus* is only found in Cape Colony in places which are very humid, such as kloofs containing a stream of running water, or in the vicinity of vleis. Apparently *I. pilosus howardi* is not limited in its distribution to these conditions. None of the above-mentioned places can be considered as humid; on the contrary, the majority of them are more or less dry, unless we can consider Durban as humid, and some of the localities—such as Leydsdorp and the Zoutpansberg Mountains—are very arid.

Most of the localities are in the low and bush veld, but those places on the high veld (above 4,000 feet), where the tick is common, are in those parts which are covered with bush, and the tick is apparently lacking in the high grass veld.

The principal host is the dog, but at the Ivy Mine, Moodies, Barberton, a few specimens were found on a cat, and a few on a hedgehog at Pienaars River.

TRANSVAAL SEA-LEVEL TEMPERATURES.

By R. T. A. Innes.

(Read April 6, 1908.)

(Plates X.–XII.)

The reduction of plateau temperatures to sea-level temperatures is a problem that does not admit a definite solution. On land-surfaces both insolation and radiation are more active than on water-surfaces, so that the variation of temperature on the former is much larger. The endeavour of the present paper is to present figures showing the reduction of Transvaal High Veld temperatures to sea-level. The figures are based on two years' means of shade temperatures published by the Transvaal Meteorological Department in its Annual Reports for 1904–05 and 1905–06. The results are independent of any hypothesis. The problem was presented thus: What reductions applied to the Transvaal temperatures will in the mean for the whole country reproduce the assumed temperatures at sea-level? The sea-level temperatures assumed are based on Buchan's results, as published in Bartholomew's "Meteorological Atlas."

On squared paper, with the y axis for altitudes and the x axis for temperatures, points were places for the actual temperatures recorded at the different altitudes, viz., sea-level and from 460 feet to 6,300 feet, but there were only a few points for places lower than 3,000 feet, or higher than 5,700 feet. A curve drawn through these points to the point at sea-level approximated closely enough to a parabolic form; from this curve the reductions to sea-level were taken.

If it should appear that the sea-level assumption must be corrected by a certain number of degrees, it will be sufficient to apply the same correction to the Transvaal sea-level reductions. At the same time I do not consider that the tables given are final: they must be considered as a first approximation. Two years' means are an insecure foundation, and more work is wanted between the Transvaal and the sea-coast so as to fix the reduction to sea-level for intermediate heights. But it is claimed that as a first approximation the table and maps which are given will be found

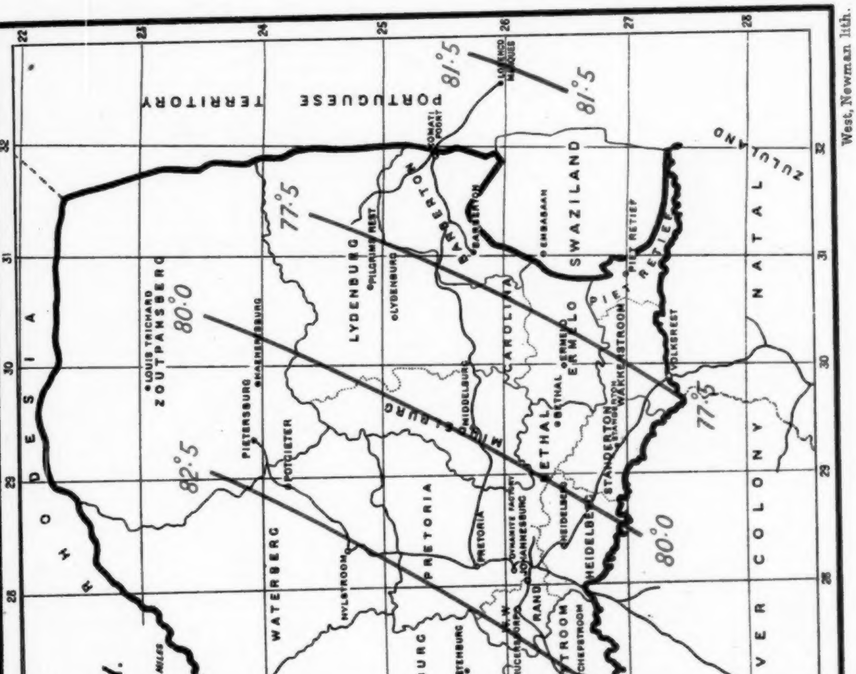
useful. If the maps are compared with Buchan's, it will be seen how different the isotherms are. In our warmest month Buchan gives as the sea-level temperature of the western border of the Transvaal something like 92½°, whereas it is actually 85°. In the absence of data, Buchan must have relied on the analogy with other continental areas, but the plateau effect and the still more potent effect of great wind movement, which is so marked a feature of South African Meteorology, greatly alter circumstances. Again, the forms of the isotherms in the mean and in the cold season deviate quite widely from Buchan's.

The table and maps which follow are so simple that they do not call for much explanation. The table shows the amount of the reduction of temperatures observed at each 500 feet of altitude. Below 2,500 and above 6,000 feet the figures are derived by extrapolation except for column two, which shows the hypothetical cooling of still dry air. It is seen that in our coldest and driest month there is some little approach to hypothetical conditions. The reduction in the warmest month, when the atmosphere is dampest, both actually and relatively, is always less than half of the still-dry-air figure.

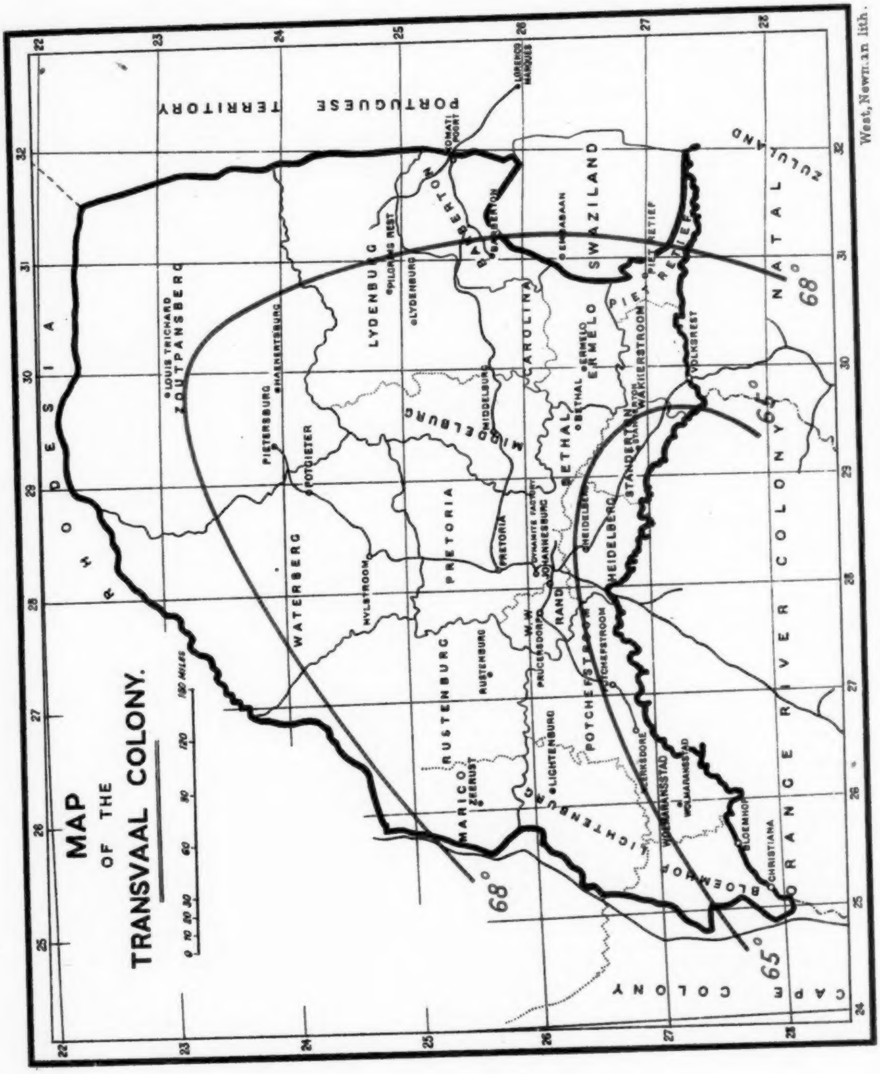
Three maps show the distribution of sea-level temperatures during the warmest and coldest months of the year and for the mean of the year.

Reduction of Observed Temperatures (Transvaal) to Sea-level Temperatures.

Altitude in Feet.	Still Dry Air.	Coldest Month.	Mean Temperature.	Warmest Month.
	°	°	°	°
0	+ 0·0	+ 0·0	+ 0·0	+ 0·0
500	2·7	2·0	1·8	1·0
1,000	5·4	4·0	3·4	2·0
1,500	8·1	6·0	4·9	3·0
2,000	10·8	7·9	6·3	4·0
2,500	13·5	9·8	7·7	5·0
3,000	16·2	11·7	9·0	6·0
3,500	18·9	13·5	10·3	7·0
4,000	21·6	15·3	11·6	8·1
4,500	24·3	17·0	12·8	9·3
5,000	27·0	18·7	14·0	10·7
5,500	29·7	20·3	15·2	12·2
6,000	32·4	21·8	16·4	13·8
6,500	35·1	23·3	17·6	15·5
7,000	37·8	24·7	18·8	17·3



West, Newman lith.



West, Newman lith.

West, Newman lith.

SOME INVESTIGATIONS REGARDING "BRACK" (ALKALI) IN CAPE COLONY SOILS.

By C. F. Juritz, M.A., D.Sc., F.I.C.

(Read at a Meeting of the Royal Society of South Africa, held on June 17, 1908.)

Plates XIII–XX.

Descending rain constantly carries clay particles from the surface down to the subsoil, and so enriches the latter with a supply of the *available* plant food which is generally contained in the finer soil grades, *i.e.*, the silt and clay. On the other hand, surface evaporation, causing an upward movement of the soil water, brings to the upper soil layers a constant supply of *readily* available plant food. Bearing in mind, then, the references made in a former paper * to the different grades of plant food, it may be deduced that the subsoil is constantly being supplied from the surface with plant-food constituents of Grade II., while the surface soil receives an equally continuous increment from below of the plant-food constituents of Grade I. The former of these two processes takes place more especially during the wet season, while the latter becomes more marked during the dry, but in arid regions this increase of salts in the surface soil may proceed so far, and result in an accumulation of salts of such a nature as to cause distinct injury to plant growth.

The extent to which these salts have accumulated in the surface soil can be definitely estimated only by chemical analysis,† but such analysis is of totally different nature from that which investigates the proportions of plant food or of plant-food constituents present, for we are now dealing not with beneficial but with harmful substances in the soil.

Thus the agricultural chemical analysis of soils, although as a rule confined to ascertaining whether they contain a sufficiency of plant *food*, may at times have to proceed beyond this limit and determine whether there be not an excess of plant *poison*. This generally resolves itself into an investigation of the brackness or alkalinity of the soil.

What is generally called "brack," or alkali, in soil consists in the presence of excessive quantities of certain sodium salts. These, under favour-

* S. A. Phil. Soc. Trans., vol. xviii., p. 9.

† For the present purpose this term may be considered to include the electrolytic process of the United States soil chemists.

able conditions, dissolve in the rain-water and drain out of the soil, but they accumulate and act injuriously where circumstances are unfavourable to their removal by natural drainage. During a rainy season the salts are carried to varying depths according to the penetrating capacity of the rain-water. The surface soil is thus left free from injurious salts. When dry weather sets in, however, the soil water rises to the surface as oil rises in a wick by capillary attraction, carrying the noxious salts with it from below. The water evaporates from the surface soil, leaving behind the salts as a white incrustation. There is, hence, a constant downward passage of these injurious alkaline salts during rain, and an equally constant upward movement during dry weather.

It will be easily understood that irrigation will tend to increase the accumulation of alkaline salts in a soil, seeing that the irrigation water will probably penetrate to greater depths than the rain, and carry to the surface larger quantities of salts. The danger is naturally augmented when the water used for irrigating is itself alkaline.

Hence, when adaptability of any tract of country for irrigation has to be pronounced upon, two chemical problems have to be decided: firstly, does the soil contain any constituent which may render it brack or otherwise unproductive? and secondly, assuming a satisfactory answer to the first point, is the land sufficiently provided with the necessary components of the food of plants to make farming profitable?

When the amount of plant food in a soil is the only point at issue, one needs not to probe to a greater depth than the first foot or 18 inches, but it is obvious, from what has been stated above, that in order to ascertain not only whether a soil is at present unproductive through brackness, but also whether it is liable to become so when irrigated, it is not enough to take merely a sample of soil from the surface and analyse that. It is essential to take samples at regular intervals below the surface to a depth at least equal to that which the irrigation water may possibly reach. There should be no omission that may leave a loophole for mistake. For this reason the method employed is to take samples representing successive sections vertically downwards from the surface to a depth of from 4 to 6 feet. Generally 1-foot sections are taken, but in certain cases 10-inch, 8-inch, or even 3-inch sections have been collected as occasion seemed to demand. Sometimes it has been advisable to sample solid blocks of soil, for instance, in the Thebus investigation, where the following method was used:—

A hole, several feet in diameter, was excavated to a depth of 6 feet, a solid pillar of earth being left untouched in the centre. From this central pillar six samples were taken in each case, every sample representing the average of 1-foot depth of soil. It will be readily seen that such a method of sampling involves more labour than scraping a couple of handfuls of

soil from the surface—a method which has sometimes been employed with somewhat misleading results.

It is to the presence of alkaline salts, comprising the chloride, sulphate, and carbonate of sodium, that the brackness of a soil is due. Of these salts, sodium sulphate is the least and sodium carbonate the most injurious on account of the corrosive effect of the latter on the bark, and its puddling of the soil and so interfering with tillage; the last-named salt is the cause of what is commonly termed black brack, the dark colour being due to the organic matter dissolved by the alkaline carbonate, while the chloride and sulphate, which do not dissolve organic matter, form what is called white brack. In small quantities these alkaline salts are contained in nearly all soils, being derived from the insoluble sodium silicates, which slowly decompose under the influence of air, water, and the solar heat into the soluble salts above mentioned. Hence there is ever going on a constant addition to the soil of soluble sodium salts, and, unless means exist for a constant, and as rapid a removal of these salts, they would in time so accumulate in the soil as to render it incapable of cultivation.

As a rule natural drainage is sufficient to remove the noxious salts from the soil, and they are continually carried down to the sea by the rain-water in which they are dissolved. Exceptions to this rule, however, exist: thus, when the surface soil is porous but has an impermeable layer underneath, the alkaline salts accumulate, as it were, in a basin from which there is no outlet; or the soil may itself be so compact or otherwise constituted as to prevent proper drainage; * lastly, a high-water line in the subsoil may prevent the exit of the injurious compounds; † in all these cases, unless a remedy be provided, there can be but one result, an accumulation in the soil of the salts which render it brack.

When, therefore, drainage of a soil becomes impossible, the question to be considered is whether the alkaline salts may collect at any particular level, or whether, on the other hand, they will be more or less evenly distributed throughout a mass of soil several feet in thickness. In such localities where rain is frequent and the temperature not excessive the probability is that the salts will be fairly evenly distributed throughout the soil, so that comparatively little, if indeed any, injurious effect on the vegetation ensues. If, however, the rainfall is scanty and the climate warm, or if there even be a brief period of heavy rainfall succeeded by a dry season, time and opportunity are afforded for the harmful salts

* Such a possibility demonstrates the importance of properly ascertaining, by mechanical analysis or otherwise, the physical condition of the soil all the way from the surface, down to a depth of from 4 to 6 feet, wherever an irrigation project is under consideration.

† This again shows that if a soil is likely to prove brack under irrigation, no investigation can be considered complete unless a series of determinations of the height of the water table in the subsoil has been made.

to rise to the surface by capillary attraction, in the way already outlined, and accordingly the surface soil is given such an accumulation of salts that cultivation is greatly hindered, if not rendered absolutely impracticable.

Under these circumstances it becomes an important matter to consider what proportion of sodium salts a soil may contain and still be capable of successful cultivation. Professor Hilgard has devoted considerable time and attention to investigating this point in connection with the alkali soils of California, and he states (Bulletin No. 128): "Barley failed to grow where the total salts were ·203 per cent., but gave a full crop where they were ·159 per cent. (half of which was carbonate). Wheat is rather more sensitive; maize fails on slightly alkaline land; but certain sorghums do well on mild white alkali (*i.e.*, not containing much carbonate)."

In India Dr. Leather's experiments have led him to conclude that germination was possible where the percentage of carbonate did not exceed ·4, nor the sulphate and chloride 1 per cent. In after-growth ·2 per cent. of carbonate was harmful, and ·4 generally fatal. Maize was least affected of the cereals. Wheat grew well in the presence of ·137 per cent. of carbonate, but was destroyed by ·2 per cent. Legumes are more affected than cereals, but even the latter were fatally affected if the soil around their roots contained a proportion of ·2 per cent. of sodium carbonate.

Methods of Analysis.

The chemical analysis of an alkaline soil is far from being as arbitrary in its nature and in the method by which its results have to be interpreted as is the case with the investigations into the proportions of plant food in soils. There is therefore not always the same necessity when tabulating results of analyses of alkaline soils to specify particularly the methods adopted by the analyst. And yet it is for many reasons not only convenient, but also advisable that the methods employed in the Government laboratories should be stated here. These methods, as now carried out, are usually as follows:—

1. *Preparation of Solution.*—100 grammes of true soil (*i.e.*, the field sample sifted through a 3 mm. sieve) are placed in a flask marked to contain 1,000 c.c., and the flask is filled up to the mark with distilled water and placed in a revolving continuous shaking apparatus for twenty to twenty-four hours. At the expiration of that time the solution is either filtered under pressure through a dry filter placed in a porcelain perforated plate funnel, or by means of a Berkefeld candle filter.

2. *Determination of Total Soluble Salts.*—50 c.c. of the above soil solution are evaporated to dryness in a tared platinum dish, ignited at a temperature just below redness, so as to destroy any organic matter present, and weighed.

3. *Determination of Total Carbon Dioxide as Carbonates.*—An aliquot portion of the above soil solution is very cautiously titrated with $\frac{N}{50}$ sulphuric acid, a few drops of methyl orange, or preferably of phenacetolin, being used as indicator; from the quantity of acid used the total quantity of carbon dioxide present as carbonates is calculated.

4. *Determination of Sodium Chloride.*—To the aliquot portion used in the last determination a few more drops of $\frac{N}{50}$ sulphuric acid are added, then four drops of a chlorine-free potassium chromate solution, and titration is carried on by means of $\frac{N}{100}$ silver nitrate, all the chlorine thus determined being calculated as sodium chloride.

5. *Determination of Sulphuric Oxide.*—Another aliquot portion of the original soil solution is slightly acidulated by means of hydrochloric acid. If this causes the flocculation of clay, the mixture is filtered and the residue on the filter thoroughly washed. The clear acidulated solution is heated to boiling, and a large excess of boiling barium chloride solution is then slowly added, the mixture being allowed to continue boiling for five minutes. After the precipitate has completely settled the supernatant liquid is poured on to a filter; to the precipitate remaining in the beaker is added about 20 c.c. of boiling water, with which it is after thus washing transferred to the filter. On the filter the precipitate is again washed, at first with distilled water slightly acidulated by hydrochloric acid, and ultimately with pure water. The filter is then dried, ignited, and weighed.

6. *Determination of Sodium Sulphate and Carbonate.*—To an aliquot part of the soil solution a measured volume of $\frac{N}{50}$ sodium carbonate is added in excess of that required for complete decomposition of all calcium and magnesium sulphates, chlorides, and nitrates that may be present. The mixture is evaporated to dryness on a water bath, the residue being taken up with water and filtered, and the filter thoroughly washed. The sodium carbonate in the filtrate is then determined by titration with $\frac{N}{50}$ sulphuric acid. The quantity of $\frac{N}{50}$ sulphuric acid used in the titration, deducted from the total quantity of sodium carbonate originally added, gives the equivalents of calcium and magnesium sulphates present. The difference between the amount of sulphuric acid thus combined with calcium and magnesium and the total amount already found gives the proportion combined as sodium sulphate. Should more $\frac{N}{50}$ sulphuric acid required than the quantity of sodium carbonate originally added, the

excess over such amount is calculated as sodium carbonate. By "total alkaline salts" is understood the sum of the sodium chloride, carbonate, and sulphate.

7. *Determination of Total Lime.*—To an aliquot part of the soil solution two or three drops of rosolic acid are added; then dilute ammonia by means of a dropping tube and a sufficiency of ammonium chloride to redissolve any precipitated magnesia, after which the liquid is warmed, 20 c.c. of 4 per cent. ammonium oxalate solution are added, and the determination is further conducted exactly as in the extraction of the soil by hydrochloric acid. It may, however, be found preferable, especially when the quantity of lime is small, to dissolve the oxalate precipitate in dilute sulphuric acid and determine its amount by titration with $\frac{N}{100}$ potassium permanganate.

8. *Calcium and Magnesium Carbonates and Sulphates.*—Any carbon dioxide which may be present in excess of that combined with soda, as sodium carbonate, is calculated in the first instance as calcium carbonate. Should this not yet account for all the carbon dioxide, the rest of the latter is calculated as magnesium carbonate; on the other hand, if there still remains an excess of lime unaccounted for, it is calculated as calcium sulphate. Any excess of sulphuric oxide which may still remain is assigned to magnesia.*

HERBERT.

According to the methods outlined above, determinations of alkaline salts were made in three samples of surface soil from Douglas in the Division of Herbert. These determinations resulted as follows †:—

DOUGLAS (HERBERT DIVISION) SOILS.

Number.	Sodium Chloride.	Sodium Sulphate.	Sodium Carbonate.	Total Alkaline Salts.	Calcium Sulphate.	Calcium Carbonate.	Magnesium Sulphate.	Magnesium Carbonate.	Total Soluble Salts.	
									Calculated.	Found.
	%	%	%	%	%	%	%	%	%	%
1	·006	—	—	·006	·021	·028	—	—	·055	·048
2	·005	·002	—	·007	·001	·038	—	—	·046	·060
3	·006	·003	—	·009	—	·035	—	·003	·048	·056

* Should there be more lime or magnesia, or both, than required for the sulphuric oxide present, these are in such cases calculated as chlorides, a corresponding deduction from the sodium chloride being made.

† The results are stated in percentages, and, except where the contrary is indicated, blanks in the tables denote absence of the particular substance specified.

These results are favourable towards the suitability of the soil for irrigation, but, at the same time, had opportunity offered, it would have been desirable to extend the investigation to 3 or 4 feet lower down, for reasons already detailed, in the manner illustrated above.

Division of Colesberg.

Six soils from the farm Oorlogspoort, in the Colesberg Division, were also examined with a view to ascertaining the proportions of soluble salts present. These were found to range between ·038 and ·090 per cent., and to average ·058 per cent. Such amounts are not sufficient to be harmful to plant life, even if the salts consisted entirely of sodium carbonate or "black alkali," the most injurious form in which alkaline salts are found in the soil.

Division of Britstown.

One of the first investigations into the possible alkalinity of lands proposed to be irrigated was carried out in connection with the farm Houw Water, in the Division of Britstown. Five sets of samples were taken in almost a straight line, nearly a mile and a half from end to end, from the lands intended to be irrigated, below the site of the proposed dam. In each case samples were taken in the manner already described to a depth of 6 feet. The physical nature of the soil may be gathered from the following table:—

HOUW WATER (BRITSTOWN DIVISION) SOILS.

Surface.	A.	B.	C.	D.	E.
1st foot	Fine loose loam	Fine loose loam	Loose loam	Loose loam	Loose loam
2nd foot	,,	,,	,,	,,	,,
3rd foot	Stiff compact clay	Stiff hard clay	Stiff hard clay	Rather stiffer loam	,,
4th foot	,,	,,	,,	,,	Rather stiffer loam
5th foot	,,	,,	,,	Stiff hard clay	Looser loam
6th foot	Very loose loam	Very loose loam	,,	Loose loam	Moist loose loam

The approximate distances apart of the points whence these samples were taken were as follows:—

Between A and B	....	430 yards
,, B ,, C	....	250 ,,
,, C ,, D	....	850 ,,
,, D ,, E	....	900 ,,

Time and circumstances did not permit of any thorough investigations into the depth of the water table below the surface, but as the average annual rainfall is very low—only about 5 inches—and as E was the only one of the five probings which showed a suspicion of moisture within

6 feet of the surface, there did not appear much probability of a high water level in the subsoil.

The results of the chemical investigations into the alkalinity of these soils are given below; A 1, it should be explained, denotes an average sample of the soil at the point A from the surface to a depth of 1 foot, A 2 signifies the same soil between 1 foot and 2 feet depth, and so on.

Number.	Total Soluble Salts, per cent.	Sodium Chloride, per cent.	Sodium Sulphate, per cent.
A 1	—	·0094	—
A 2	—	·0069	—
A 3	—	·0117	—
A 4	—	·0279	—
A 5	·244	·0980	·0488
A 6	·280	·1587	—
B 1	—	—	—
B 2	·172	·0069	—
B 3	—	·0076	—
B 4	—	·0163	—
B 5	—	·0350	—
B 6	·376	·1447	—
C 1	·264	·0058	—
C 2	·176	·0069	—
C 3	·136	·0076	—
C 4	·168	·0117	—
C 5	·200	·0117	—
C 6	—	·0163	—
D 1	—	—	—
D 2	·400	·0094	—
D 3	·392	·0398	—
D 4	·496	·1261	—
D 5	·600	·2357	—
D 6	·760	·2754	—
E 1	—	·0117	—
E 2	·348	·1028	—
E 3	·640	·3080	—
E 4	·920	·4155	·4189
E 5	1·284	·5438	—
E 6	1·636	·6272	—

These analyses were somewhat tentative, and, owing to lack of time and also of the necessary filtering and other appliances, the tables are

studded with gaps. These drawbacks, however, do not prevent certain definite deductions. It is noticeable that, as a rule, the amounts of sodium chloride, and of soluble salts generally, steadily increase as we proceed downward from the surface to the 6-foot limit, and that this downward limit increase becomes more rapid as we pass from A towards E.

Taking the entire 6-feet depth of soil, in each case the average percentages of salts, as far as they may be based on the foregoing determinations, are as follows:—

	Total Soluble Salts.	Sodium Chloride.
A	—	·0521
B	—	·0421
C	·189	·0100
D	·530	·1373
E	·966	·3348

The question now to be pronounced on is: What would be the effect of irrigation upon such soils? Broadly speaking, and having no regard to modifying causes, there can be only one answer. The result of irrigation would assuredly be to raise the bulk of the alkali salts, within the first 4 feet of soil, to the surface.

It appears most probable that the low rainfall in the district around Houw Water, accompanied by other causes, prevents the water from ever penetrating the soil to any great extent, and, therefore, from bringing up the salts during subsequent evaporation. Irrigation would very probably alter all this. The large quantity of water led on to the soil is bound to penetrate, and, when evaporation follows, as it undoubtedly must, large quantities of salt will be carried up to the surface, and accordingly render the surface soil more saline.

In connection with some alkaline soils it has been found at Tulare, in California, that, although the salts in the soil have been drawn upwards, they have not been drawn right to the surface, and, in spite of the fact that a considerable amount of alkaline salts was present in the soil, there was not sufficient at the surface to cause any interference with the growth of shallow-rooted crops like barley, which flourished, to all appearances, satisfactorily. The reason for this is to be found in the fact that the surface soil was kept under constant cultivation, whereby evaporation from the soil itself was checked, and proceeded instead from the verdure of the cultivated crops. If the land can be kept under continuous cultivation, there would be simultaneously two causes at work to retard evaporation, and consequently prevent the rise of alkaline salts to the surface. Evaporation from foliage instead of from soil would not be the only saving factor, but the shading of the ground by the crops reducing its temperature, still further diminishes the tendency to evaporation from the soil surface.

It would appear that the most noxious of the sodium salts, the carbonate, is practically absent from the Houw Water soils, the two compounds of sodium which form the bulk of the alkaline soil constituents being the sulphate and the chloride. Professor Hilgard estimates that, for barley, sandy soils should not contain within the first 12 inches over ·10 per cent. of sodium carbonate, ·25 per cent. of sodium chloride, or ·45 to ·50 per cent. of sodium sulphate; in clayey soils even smaller percentages may prove injurious. It has been calculated that the average proportion of total alkaline salts in the 4 feet nearest the surface should not exceed ·2 per cent. if barley is to be grown. According to Professor Hilgard's experiments, as already stated, barley thrived on a soil which contained on an average ·159 per cent. of alkaline salts in the first 4 feet; on the other hand, the cereal refused to grow where the average amount in the first 4 feet reached ·203 per cent. Now, of the Houw Water soils it seems likely that A would satisfy this condition, and possibly B may also; the average percentage in C is ·186, but both D and E are considerably on the worse side of the danger limit.*

Division of Steynsburg.

A similar investigation to that outlined above was made at Thebus, in the Steynsburg Division, a distance of about 160 miles E S.E. of Houw Water. In this case, too, there was a proposal afoot to construct a dam whereby the farm Zout Kuil and part of Van Vuurens Kraal with adjacent lands could be irrigated. As Parliament had voted £150,000 for the purpose, much depended on the suitability of the area. The last-named farm had been under cultivation for close on to half a century, and the occupant prided himself on the returns which he has obtained by means of irrigation. At a point within this cultivated area a set of samples was taken in order to ascertain, if possible, the effect of continuous irrigation on the soil, by comparing the analytical results yielded by the irrigated soil at this spot, which will be called K, with those of samples from the adjacent tracts which had never yet been irrigated. This point, K, was on the opposite side of the railway to that where the dam construction works were situated, and is rather more than 3 miles below the dam, and 1½ mile from Thebus railway station; it constituted, in fact, the head of the area which it was intended to irrigate. Four samples, L, M, N, and P, were taken at other points in this area, on the farm Zout Kuil, extending altogether over a space about 2 miles in extent.

The alkaline salts in these five samples were determined in similar manner to that employed with regard to those from Houw Water, only much more completely.

In this way the following percentage results were obtained:—

* It is of course obvious that efficient drainage may prove a complete safeguard.

THEBUS (STEYNSBURG DIVISION) SOILS.

Number.	Sodium Chloride.	Sodium Sulphate.	Sodium Carbonate.	Total Alkaline Salts.	Calcium Sulphate.	Calcium Carbonate.	Magnesium Sulphate.	Magnesium Carbonate.	Total Soluble Salts.	
									Calculated.	Found.
	%	%	%	%	%	%	%	%	%	%
K 1	·034	—	—	·034	—	·006	·007	·024	·071	·204
K 2	·033	·012	—	·045	—	·015	·004	·060	·124	·232
K 3	·055	—	—	·055	—	·013	·049	·053	·170	·258
K 4	·083	·210	—	·293	·283	·028	·212	—	·816	·872
K 5	·073	·237	—	·310	·030	·029	·121	—	·490	·496
K 6	·103	·181	—	·284	·067	·031	·274	—	·656	·700
L 1	·191	·048	—	·239	—	·019	·017	·023	·298	·372
L 2	·161	·181	—	·342	·144	·035	·224	—	·745	·660
L 3	·118	·120	—	·238	—	·026	·035	·015	·314	·230
L 4	·173	·082	·002	·257	—	·019	—	·035	·311	·340
L 5	·205	·108	·005	·318	—	·016	—	·043	·377	·380
L 6	·102	·088	·039	·229	—	·011	—	·057	·297	·328
M 1	·086	—	—	·086	—	·021	·013	·001	·121	·252
M 2	·211	—	—	·211	—	·033	·025	·022	·291	·416
M 3	·277	·101	—	·378	—	·026	·020	·028	·452	·582
M 4	·224	·293	—	·517	·051	·035	·080	—	·683	·800
M 5	·242	·037	—	·279	—	·021	·159	·031	·490	·508
M 6	·291	·304	—	·595	—	·024	·030	·034	·683	·880
N 1	·213	·071	—	·284	—	·013	·004	·034	·335	·348
N 2	·234	·208	—	·442	—	·034	·071	·012	·559	·594
N 3	·181	·131	·063	·375	—	·010	—	·079	·464	·568
N 4	·221	·127	·056	·404	—	·010	—	·072	·486	·480
N 5	·251	·096	·058	·405	—	·008	—	·088	·501	·452
N 6	·193	·070	·048	·311	—	·013	—	·072	·396	·394
P 1	·225	·115	·012	·352	—	·008	—	·040	·400	·664
P 2	·271	·762	—	1·033	·572	·023	·279	—	1·907	2·160
P 3	·193	·146	·111	·450	—	·010	—	·101	·561	·608
P 4	·159	·104	·111	·374	—	·008	—	·116	·498	·604
P 5	·205	·055	·129	·389	—	·009	—	·125	·523	·672
P 6	·216	·023	·156	·395	—	·019	—	·142	·556	·570

It will be seen that the soil at K is the only one which falls within the limits of safety as laid down by Professor Hilgard; in fact K is the only soil which one would expect to yield a profitable return, and the fact that farming has been carried on there with fair success does not therefore settle the matter for the entire valley. The lower layers of the soil at K contain a fair proportion of gypsum which has converted the noxious sodium carbonate into the less harmful sulphate. There is a general prevalence of carbonate of lime throughout these soils, and in nearly every case a stratum of gypsum (calcium sulphate) runs through the soil at various levels; this stratum appears in the fourth foot at K and M, and in the second at L and P. It is invariably accompanied by an increase in the proportion of other soluble salts, including those which produce

brack, and although the gypsum in these layers may minimise to some extent the evil effects of the black brack by converting it into sodium sulphate, it is not probable that it will do away with these effects entirely.

There is a general resemblance between the soils K and M, the former being an improvement on the latter. The worst kind of brack, sodium carbonate or black brack, occurs in the soils L, N, and P. At L it makes its appearance at the fourth foot, at N it rises to the third, and in larger proportions, while at P it appears at the surface, and is distributed through the soil profile in amounts averaging from two to three times those in the corresponding soil layers at N.

It will be noticed that the magnesium salts exceed, on the whole, the lime salts in quantity, and I may here say—what does not appear from the figures already given—that the soils K and M show a small proportion of the rather undesirable magnesium chloride in the first couple of feet.

The amounts of alkaline carbonates in the Thebus samples are lower than in the soils of the Tulare Experiment Station, California, as reported by Professor Hilgard, and the alkaline salt present in largest proportion is sodium sulphate at K, and sodium chloride at the other points where samples were taken; but then the Californian Station may be taken as representing an extreme case, and there is no saying whether much worse instances than the present may not be found at Thebus if a more complete investigation be undertaken.

It will be noticed how irregularly the soluble salts are distributed through the soil; this irregularity is caused by the varying permeability of the soil layers, and by the bands of gypsum which traverse the valley. This variability also showed itself in the peculiar nature of results obtained by ordinary agricultural chemical analysis from other samples collected at Thebus. These samples were evidently not typical, and may even, in some cases, have been taken out of the very bands of gypsum just mentioned, hence they showed abnormal percentages of lime. Irregularities of this type are of common occurrence in alkali soils; King ("Irrigation and Drainage," p. 283) states that "in examining soil for alkalies it is a matter of the utmost importance to recognise that the distribution of them is extremely liable to be capricious, and that it is easy to overlook their presence by stopping the sampling of the soil just short of the level at which all the alkalies had chanced to be concentrated; or, again, by taking a sample of the first, second, and fourth feet, or of the first, third, and fourth feet, when, owing to the capricious distribution, all of the salts had been collected in the second and third foot, and thus were overlooked because it may have been thought not worth while to make a complete section of the soil in question."

An analysis was made of a sample of efflorescence from the soil in the

neighbourhood of the works, obtained by enclosing a quantity of the soil, to a depth of several feet, with a metal cylinder, drenching the soil with water and allowing it to dry by exposure. As was to be expected, evaporation of the water led to the appearance of a layer of salts on the surface, and this layer, on being scraped off, was found to have the following composition :—

Sodium chloride	40·16 per cent.
Sodium sulphate	11·64 ,,
Magnesium sulphate	37·21 ,,
Calcium sulphate	10·86 ,,
Calcium carbonate	Trace

Of the alkaline salts that present in largest amount is sodium chloride, and the magnesium compounds exceed those of calcium in quantity. In the absence of sufficient lime this magnesia may prove harmful.*

Two similar samples of efflorescence mixed with earth, collected by Dr. Nobbs near the same spot, were analysed with the following results :—

Total soluble salts	1·209 per cent.	1·495 per cent.
Sodium chloride	·058 ,,	·491 ,,
Sodium sulphate	1·122 ,,	·895 ,,
Magnesium sulphate	— ,,	·048 ,,
Magnesium carbonate	·008 ,,	—
Calcium carbonate	·010 ,,	·020 ,,

Here, too, it will be seen sodium sulphate prevailed.†

In a sample of water, taken from a pit on the site of the proposed dam, the total dissolved salts amounted to 50·40 grains per gallon ; of these salts the following are the principal ingredients :—

* See Storer, "Agriculture in some of its Relations with Chemistry," vol. ii., pp. 518 and 519.

† From the farm Culmstock, in the Division of Middelburg, and lying about 20 miles south of Thebus, a sample of efflorescence, such as frequently occurs on the surface of brack soils, was collected. Analysis showed it to contain, *inter alia* :—

Chlorine	7·8 per cent.
Carbon dioxide	6·2 ,,
Sulphur trioxide	33·8 ,,

The salts present therefore consisted mainly of sulphates. In both these Divisions (Steynsburg and Middelburg) there are extensive plains of Karroo veld, which, but for the liability to brack, would answer excellently for irrigation and cultivation purposes.

	In grains per gallon.	In parts per thousand.
Sodium chloride	6·35	·091
Sodium sulphate	6·76	·097
Sodium carbonate	6·68	·095
Magnesium carbonate	16·54	·236
Calcium carbonate	8·87	·127

Here again, as in the soils and also in the efflorescence taken from the surface of the soil, magnesium compounds form the chief ingredient. Sodium carbonate is present in small quantity, the amount being apparently less than in the water from Thebus dam.

The latter yielded the following results in grains per gallon :—

Total salts	45·2
Sodium chloride	6·3
Carbon dioxide in combination	12·8

The water from the dam contains but small quantities of lime and magnesia, so that in all probability the carbon dioxide in it was combined with soda, forming sodium carbonate, and the use of it, unless accompanied by effective drainage, would therefore tend to increase in the soil that most injurious form of alkali, "black brack." The water from the pit, on the other hand, had most of its carbon dioxide combined with lime and magnesia.

On p. 266 of King's "Irrigation and Drainage" will be found a table, compiled from Bulletin 29 of the Oklahoma Experiment Station, p. 4, showing the composition of alkaline waters that may be regarded as safe and those which are considered unsafe to use for irrigation.

Bearing in mind that sodium carbonate represents what is called "black alkali" in King's tables, and that sodium chloride and sulphate together constitute "white alkali," it will be seen that the amounts in the pit water are as follows :—

Black alkali	·095 part per thousand.
White alkali	·188 „ „ „

Now, it is to be noticed from the tables in King's book that a water may be considered safe if the black alkali—which is the most harmful constituent—does not exceed, say, ·100 part per thousand, provided the white alkali be not too high, but that if the former exceed the figure just mentioned the water cannot be regarded as safe. White alkali is less injurious, and up to about ·500 part per thousand may be passed, but beyond this limit, even though the black alkali may be low (as in the case of sample 741 of the tables alluded to, where the black alkali is ·026 and the white ·818 per thousand) it would be risky to make constant use of the water.

In the sample of water from the pit at Thebus the white alkali was well within the limits of safety, but the black alkali was on the border-line, and in the sample of water from the dam the limit was apparently exceeded, although the smallness of the sample sent prevented this being definitely ascertained.

It must, of course, be kept in view that the figures with which the analytical results of the Thebus water are compared are derived from experimental data obtained in Europe and America. If the facilities for making such very necessary experiments existed here, figures obtained under local conditions might be found to differ from those obtained in Europe and in the United States, but this very fact makes it all the more necessary to exercise great caution in proceeding with extensive irrigation schemes.

Division of Robertson.

A series of determinations, similar to those conducted in regard to the Thebus soils, have also been made in connection with the soil of the Government Experiment Station at Robertson. Two soils were collected for this purpose on the station. The soil at one part of the farm was a red sandy loam with a clayey subsoil and tending towards brackness in parts. From one of these brack patches the samples marked S were taken. A calcareous loam, in another part of the farm, showed brack

ROBERTSON SOILS.

Number.	Sodium Chloride.	Sodium Sulphate.	Sodium Carbonate.	Total Alkaline Salts.	Calcium Sulphate.	Calcium Carbonate.	Magnesium Sulphate.	Magnesium Carbonate.	Total Soluble Salts.	
									Calculated.	Found.
	%	%	%	%	%	%	%	%	%	%
R 1	·024	—	—	—	—	—	—	—	—	·060
R 2	·018	—	—	—	—	—	—	—	—	·044
R 3	·010	—	—	—	—	—	—	—	—	·070
R 4	·011	—	—	—	—	—	—	—	—	·062
R 5	·011	—	—	—	—	—	—	—	—	·056
R 6	·019	—	—	—	—	—	—	—	—	·080
S 1	1·029	·162	—	1·191	·112	·020	·043	—	1·366	1·400
S 2	·942	·114	—	1·056	·088	·020	·071	—	1·235	1·272
S 3	·662	·037	—	·699	—	·037	·067	·003	·806	·858
S 4	·516	·071	—	·587	—	·029	·041	·018	·675	·700
S 5	·487	·082	—	·569	—	·024	·014	·027	·634	·674
S 6	·409	·082	—	·491	—	·018	·014	·030	·553	·572
S 7	·342	·062	—	·404	—	·016	·014	·005	439	·504
S 8	·301	·067	—	·368	—	·014	·007	·005	·394	·450
S 9	·291	·066	—	·357	—	·009	·012	·011	·389	·428
S 10	·307	·073	—	·380	—	·012	·012	—	·404	·476
S 11	·321	·076	—	·397	—	.007	·012	·004	·420	·496

(The blanks in the *upper* part of this table signify "undetermined.")

water a short distance from the surface. Under these circumstances fuller investigations into the alkaline character of the soil were made. At two spots, R and S, the samples mentioned below were collected representing successive sections of the soil to a total depth of 4 feet; at R, six samples, each extending vertically through 8 inches, were taken; at S, an alkaline patch with a superficial area of about 2,000 square yards, eleven samples were taken, of which the first eight represented 3-inch, and the remaining three 8-inch vertical sections.

The analyses made resulted as shown in Table on previous page.

In the case of the soil R there was no necessity to push the investigation further, the total soluble salts being considerably below the danger limit. At S a very different condition of things exists, and a diagram is attached, showing the curves of the various soluble salts in the soil as we descend from the surface to a depth of 4 feet.

Division of Carnarvon.

An investigation of the alkaline tracts near the large dam called Van Wyks Vlei, 45 miles north-west of Carnarvon village, was conducted, on lines somewhat similar to those already indicated. By means of this dam, which holds many thousand million gallons of water, fairly extensive irrigation has been practised for several years. Under this treatment the barren area has gradually spread, and at present the nearest land that is being cultivated below the dam is no less than 7 miles distant therefrom. It is, nevertheless, estimated that about 20,000 acres of irrigable land of good quality are still free from any signs of alkalinity, and available for cultivation.

Two samples of water from artesian borings in the vicinity of the dam were analysed, with the following results, stated in grains per gallon:—

	No. 1.	No. 2.
Sodium chloride	48·94	358·98
Magnesium sulphate	49·20	177·57
Calcium sulphate	53·26	76·86
Calcium carbonate	10·16	147·95

A specimen of water from the dam itself was found to contain chlorine —in combination as chlorides—to the amount of 1154·6 grains per gallon, and, on another occasion, a sample similarly taken yielded the following figures:—

Sodium chloride	862·9 grains per gallon
Sodium sulphate	226·3 ,, ,, ,,

At some places in the neighbourhood beds of limestone, containing gypsum occur: specimens of these were analysed, but did not prove of good quality.

The land most affected by alkaline salts is that in the immediate proximity of the dam, and from there the saline area is working its way downwards by degrees, the lands being drenched with water during the season, and then left to the action of evaporation, which does not fail to draw the salts to the surface, with the consequence that, in the long run, one area after another has been discarded as too salt for cultivation. Under such circumstances, the practice has been to transfer to a plot of virgin soil until that, in turn, becomes too alkaline for use.

To test chemically the results that this mode of cultivation brings about, samples of soil, T and V, were taken, respectively, from Lot 111, which had been under cultivation for seventeen years, and had, during that period, grown fourteen crops of wheat, and from Lot 94, which had never been cultivated, at a spot 315 yards from that where T was collected. The crops at T were originally as good as could be desired, but have been gradually deteriorating. The sample taken at V is typical of the Van Wyks Vlei soil in its natural state.

The way in which these samples were collected was as follows: In each case an excavation was made to a depth of 7 feet, and, down one side of the excavation, a vertical groove, of 6 inches square section, was cut by removing for analysis blocks of soil of 6 inches cube at 6-inch intervals. The first sample of each series was taken from the surface to a depth of 6 inches, and then samples of each alternate 6 inches below that. In both cases, at a depth of 6 feet, a stratum consisting for the most part of large-sized stones was encountered; of this it was not considered necessary to make analyses, but the soils taken from the higher levels were examined for alkaline salts, with the results tabulated below:—

VAN WYKS VLEI (CARNARVON DIVISION) SOILS.

Number.	Sodium Chloride.	Sodium Sulphate.	Total Alkaline Salts.	Calcium Chloride.	Calcium Sulphate.	Calcium Carbonate.	Mangesium Chloride.	Magnesium Sulphate.	Magnesium Carbonate.	Total Soluble Salts.	
										Calculated.	Found.
	%	%	%	%	%	%	%	%	%	%	%
T 1	·849	—	·849	1·542	·106	·014	·046	—	—	2·557	2·672
T 2	·432	—	·432	·114	·040	·022	·029	—	—	·637	·708
T 3	·355	—	·355	·039	·081	·024	·017	—	—	·516	·548
T 4	·359	·105	·464	—	·003	·038	—	·036	—	·541	·594
T 5	·304	·363	·667	—	·049	·034	—	·065	—	·816	·840
T 6	·214	·397	·611	—	—	·037	—	·007	·011	·666	·664
V 1	·051	—	·051	·068	·019	·024	·012	—	—	·174	·222
V 2	·355	—	·355	·500	·032	·026	·090	—	—	1·003	1·056
V 3	·590	—	·590	·404	·071	·020	·066	—	—	1·151	1·210
V 4	·736	—	·736	·082	·198	·026	·055	—	—	1·097	1·102
V 5	·759	·318	1·077	—	·042	·048	·007	·053	—	1·227	1·238
V 6	·502	·419	·921	—	·105	·017	·006	·049	—	1·098	1·116

The effect of irrigation, as practised at Van Wyks Vlei, on this type of soil, is seen, in the case of soil T, by the accumulation of salts at the surface. In its natural condition the vertical distribution of the saline material is such as to leave the surface soil comparatively free, so that shallow-rooted crops may be cultivated without difficulty. In the irrigated soil the present failure to grow crops is easily explained by the existence of the chlorides of calcium and magnesium in the upper soil layers. The occurrence of these very soluble salts in "brack" is somewhat unusual, and can only take place in arid regions like Carnarvon. At Thebus, too, where the rainfall is not abundant—although less scanty than in the Carnarvon Division—the presence of magnesium chloride in the soil was noticed. In the Robertson Division, on the other hand, where rain is frequent and the atmosphere more humid, a surface efflorescence containing these salts is an impossibility.

It will be noticed, especially from the appended diagram, that, in the irrigated soil, the chlorides are, for the most part, accumulated within the upper 30 inches, while the sulphates have remained at the lower levels.

Calculating from the figures in the last table, the percentage composition of the salt at the soil surface at T is as follows :—

Sodium chloride	33·20
Magnesium chloride	1·80
Calcium chloride	60·30
Calcium sulphate	4·15
Calcium carbonate	·55

With this may be compared the following results, quoted by Hilgard ("Soils: their Formation, Properties, &c.," p. 442), of an analysis of alkali occurring in California (Imperial) :—

Potassium chloride	1·15
Sodium nitrate	8·21
Sodium chloride	31·82
Sodium carbonate	·58
Magnesium chloride	2·81
Calcium chloride	58·42

There is considerable resemblance in the respective percentages of sodium, calcium, and magnesium chlorides.

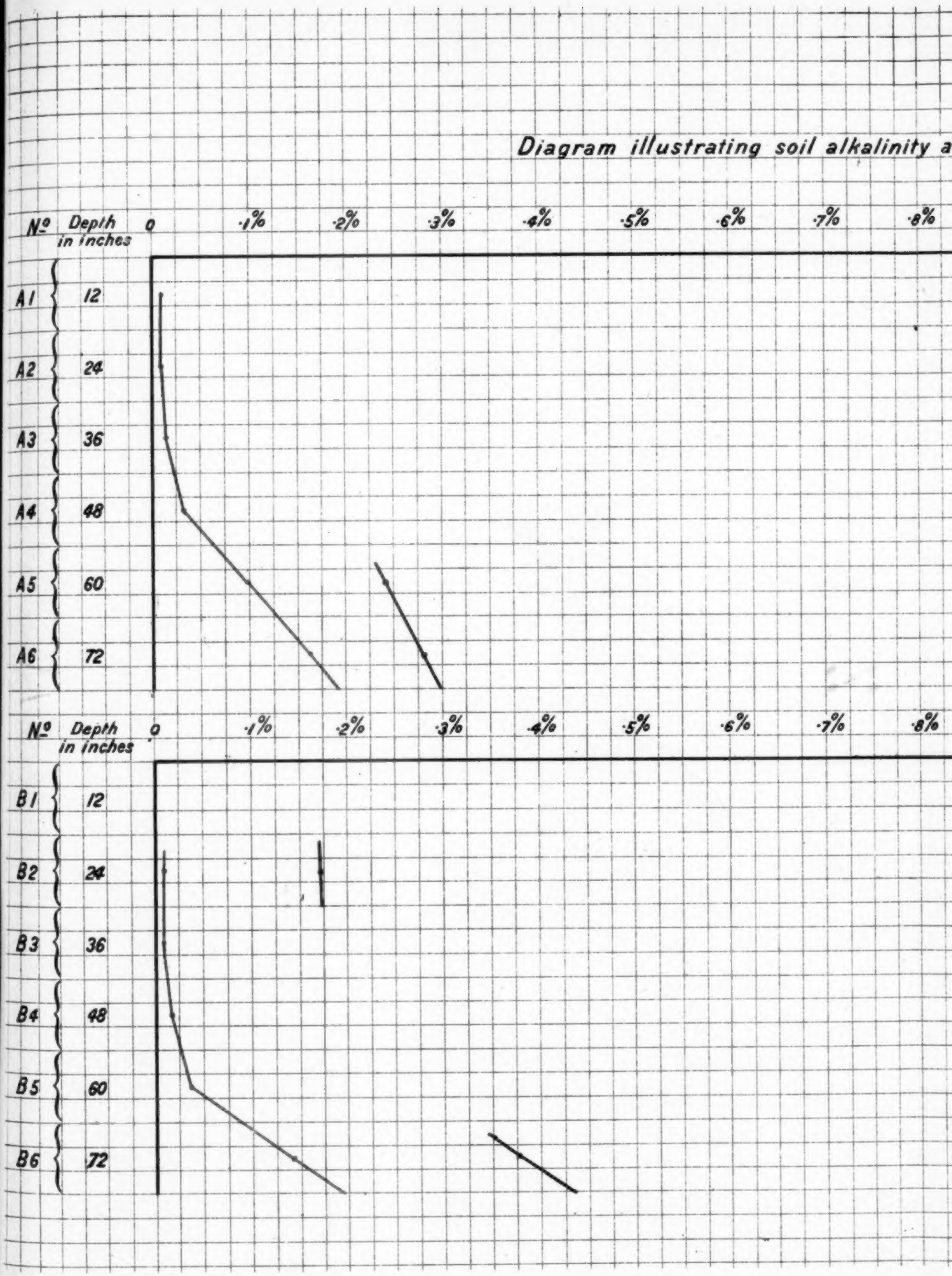
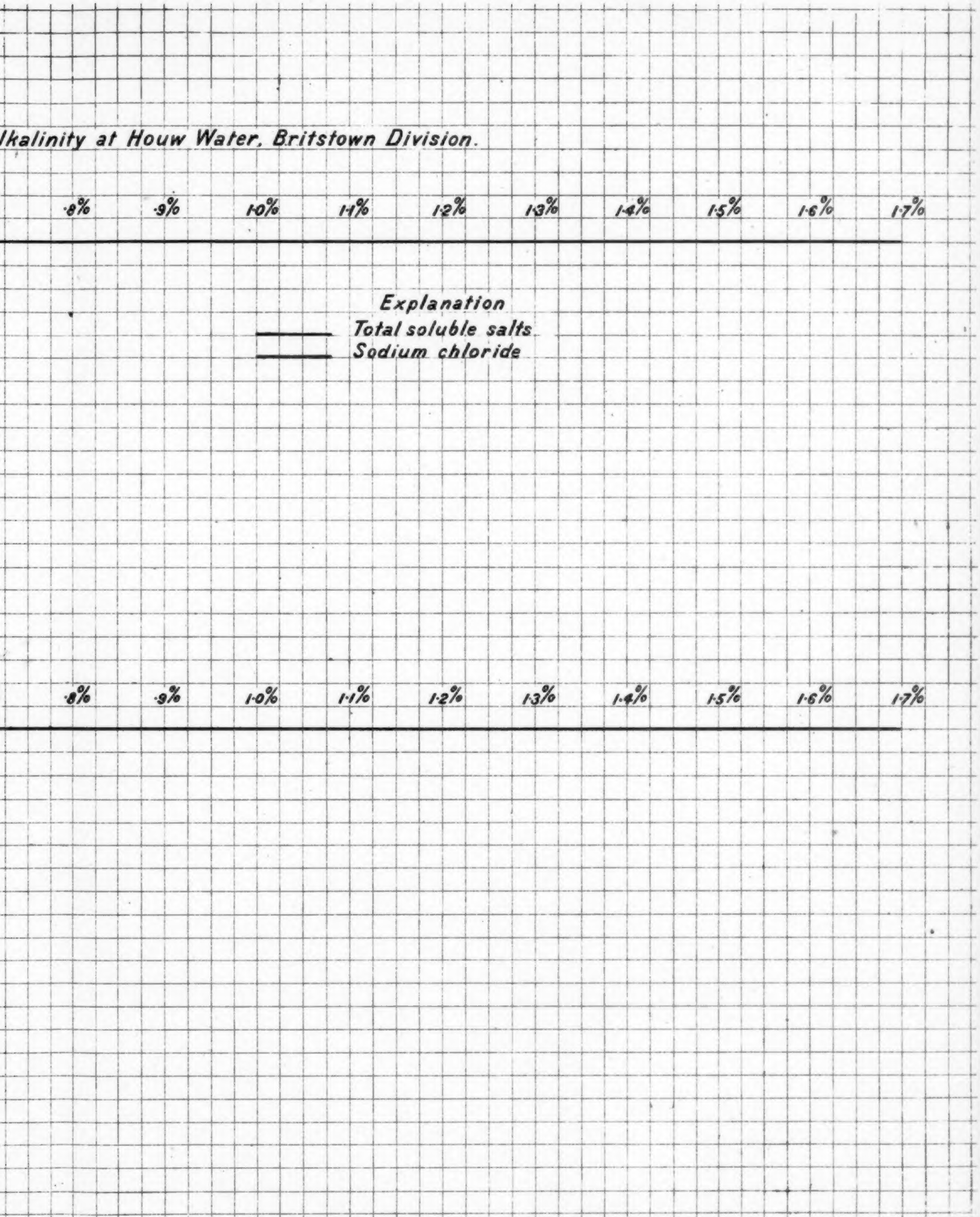


Diagram illustrating soil alkalinity a
Nº
Depth in inches
0
·1%
·2%
·3%
·4%
·5%
·6%
·7%
·8%
A1 12
A2 24
A3 36
A4 48
A5 60
A6 72
B1 12
B2 24
B3 36
B4 48
B5 60
B6 72



West, Newman lith.

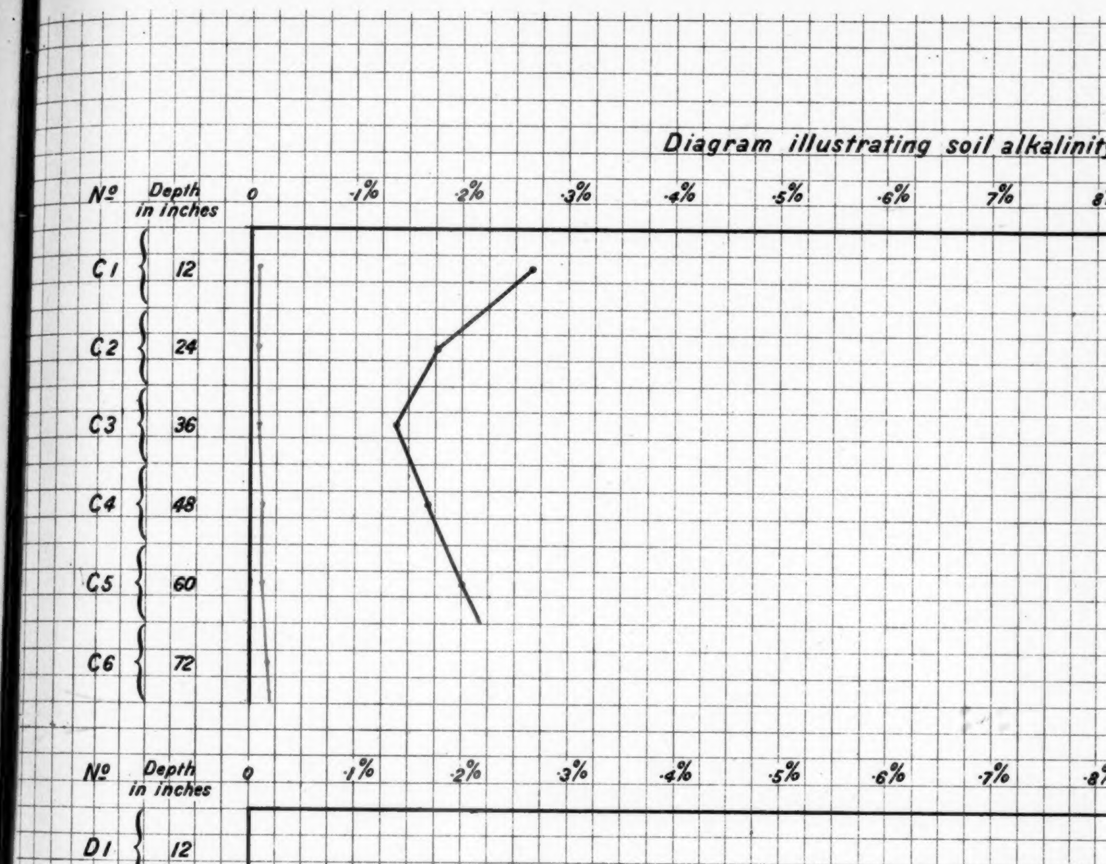


Diagram illustrating soil alkalinit
Nº
Depth in inches
0
·1%
·2%
·3%
·4%
·5%
·6%
7%
C1
12
C2
24
C3
36
C4
48
C5
60
C6
72
Nº
Depth in inches
0
·1%
·2%
·3%
·4%
·5%
·6%
·7%
D1
12
D2
24
D3
36
D4
48
D5
60
D6
72

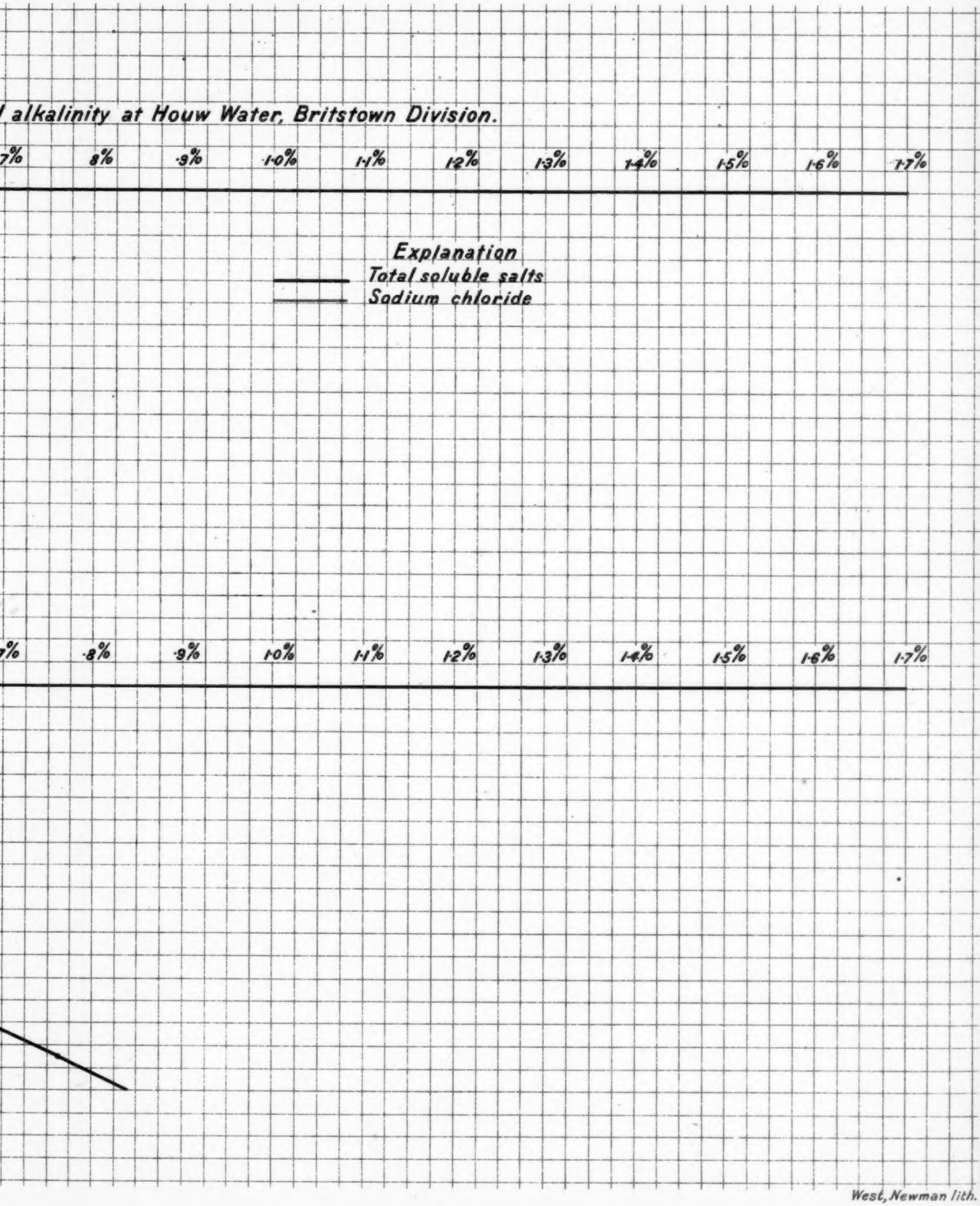


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Diagram illustrating soil alkalinity at

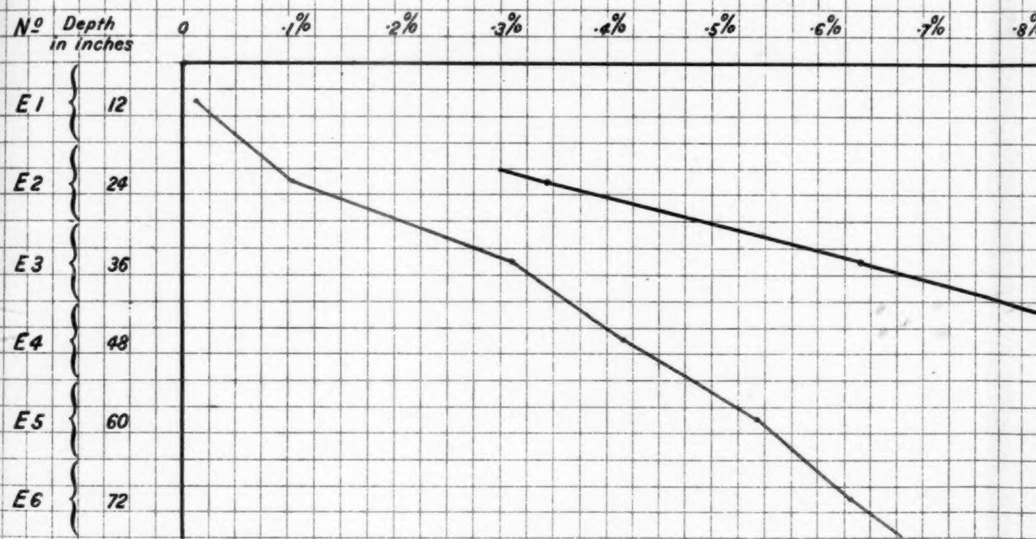
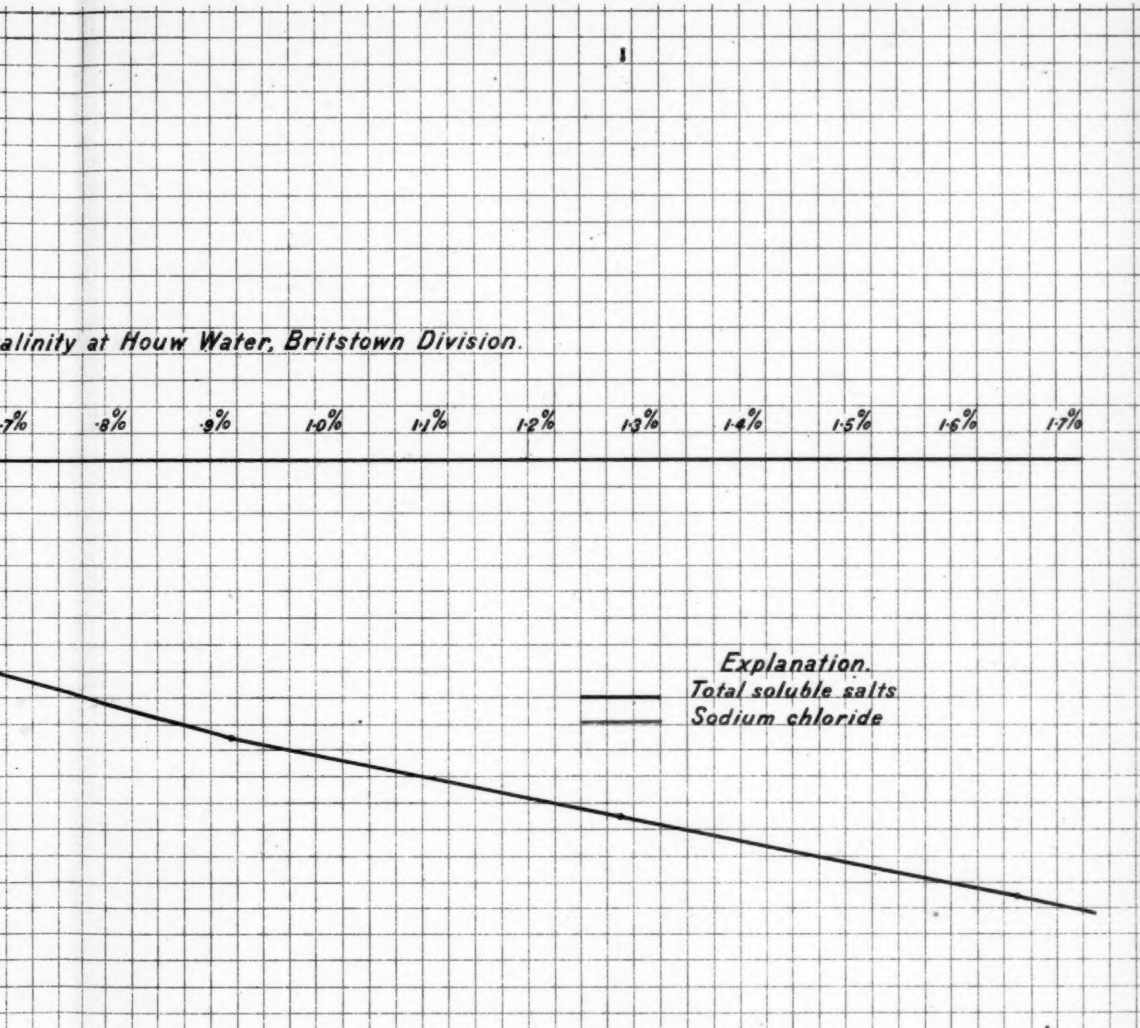


Plate XV.



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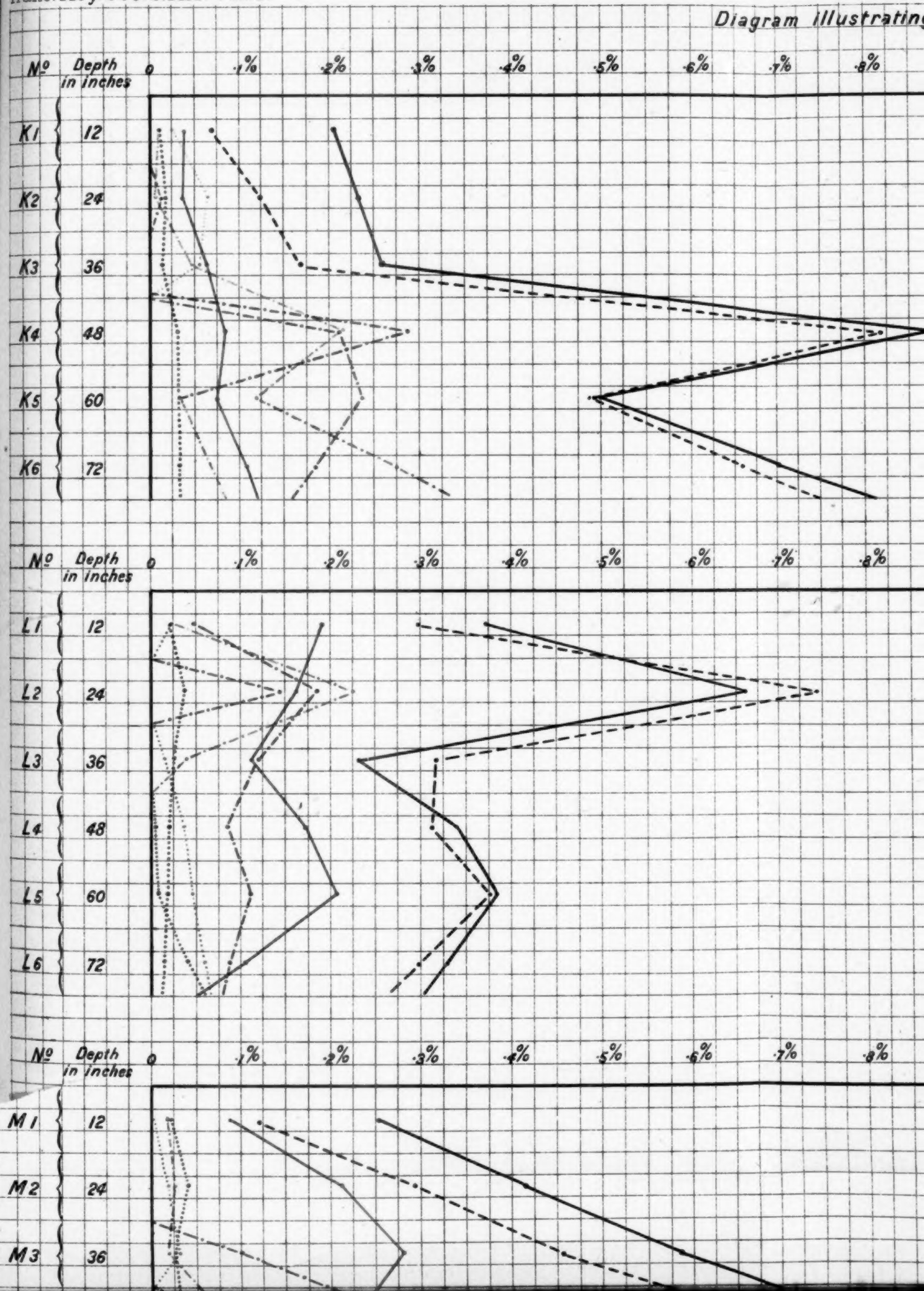
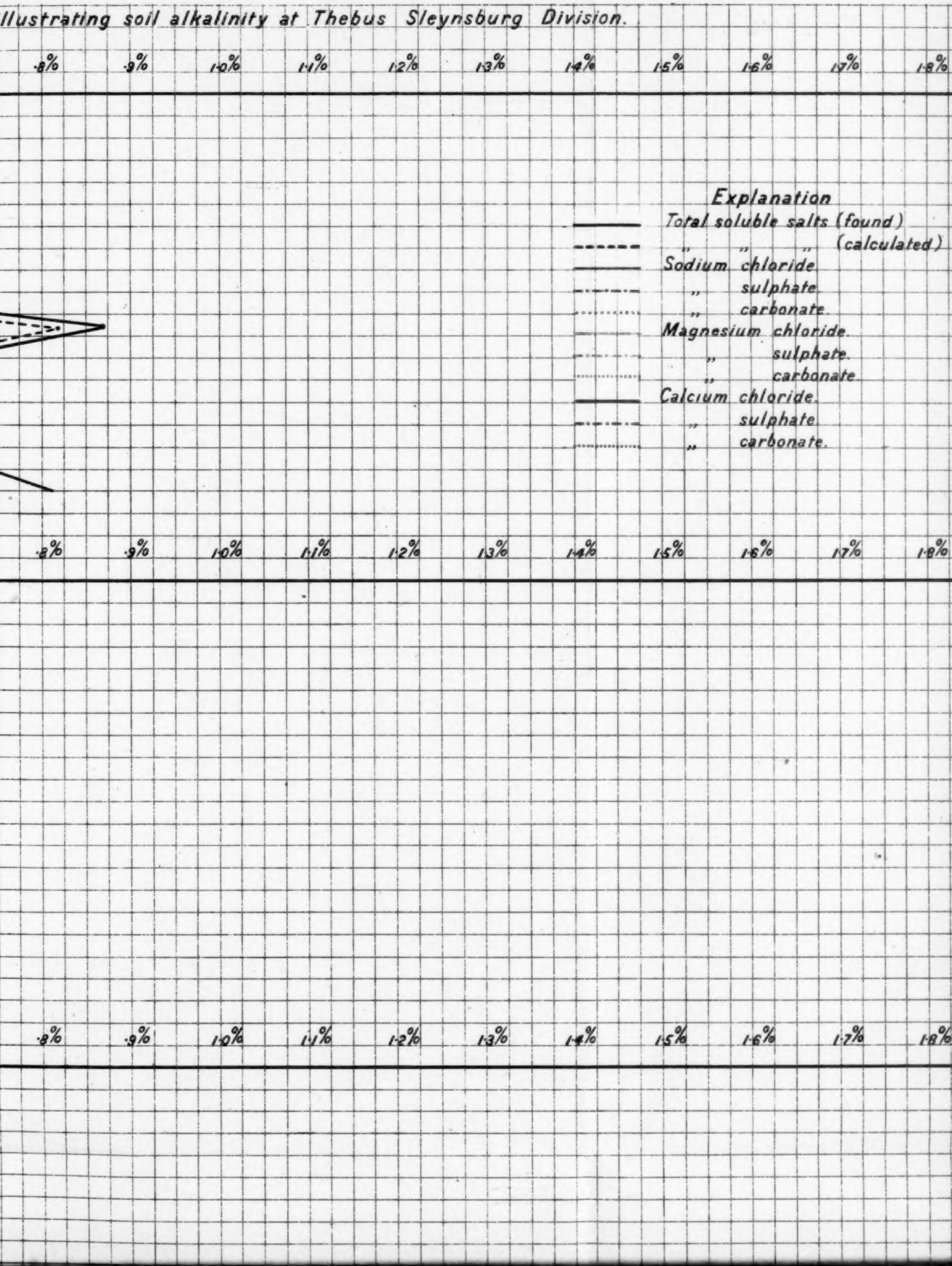
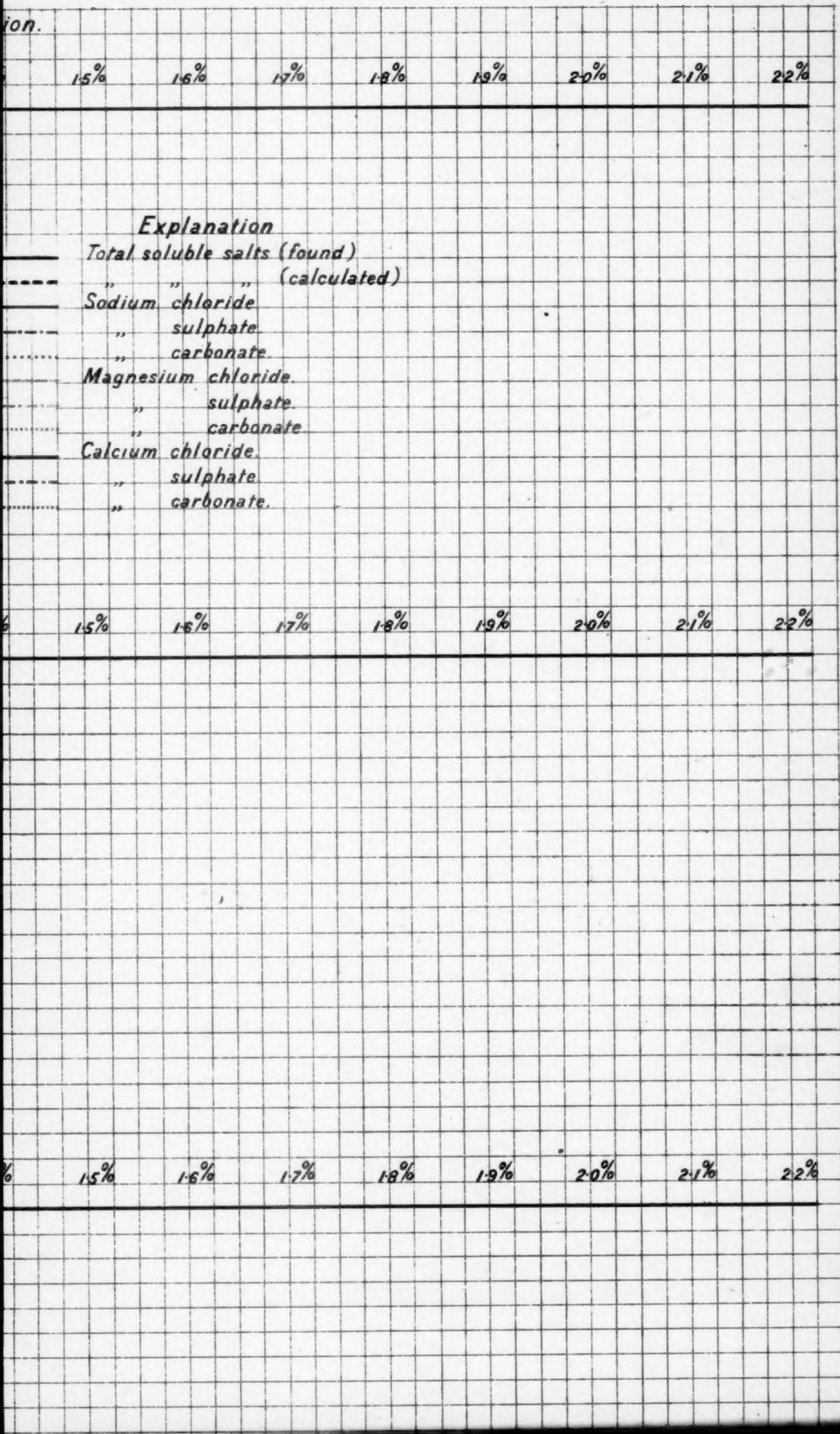


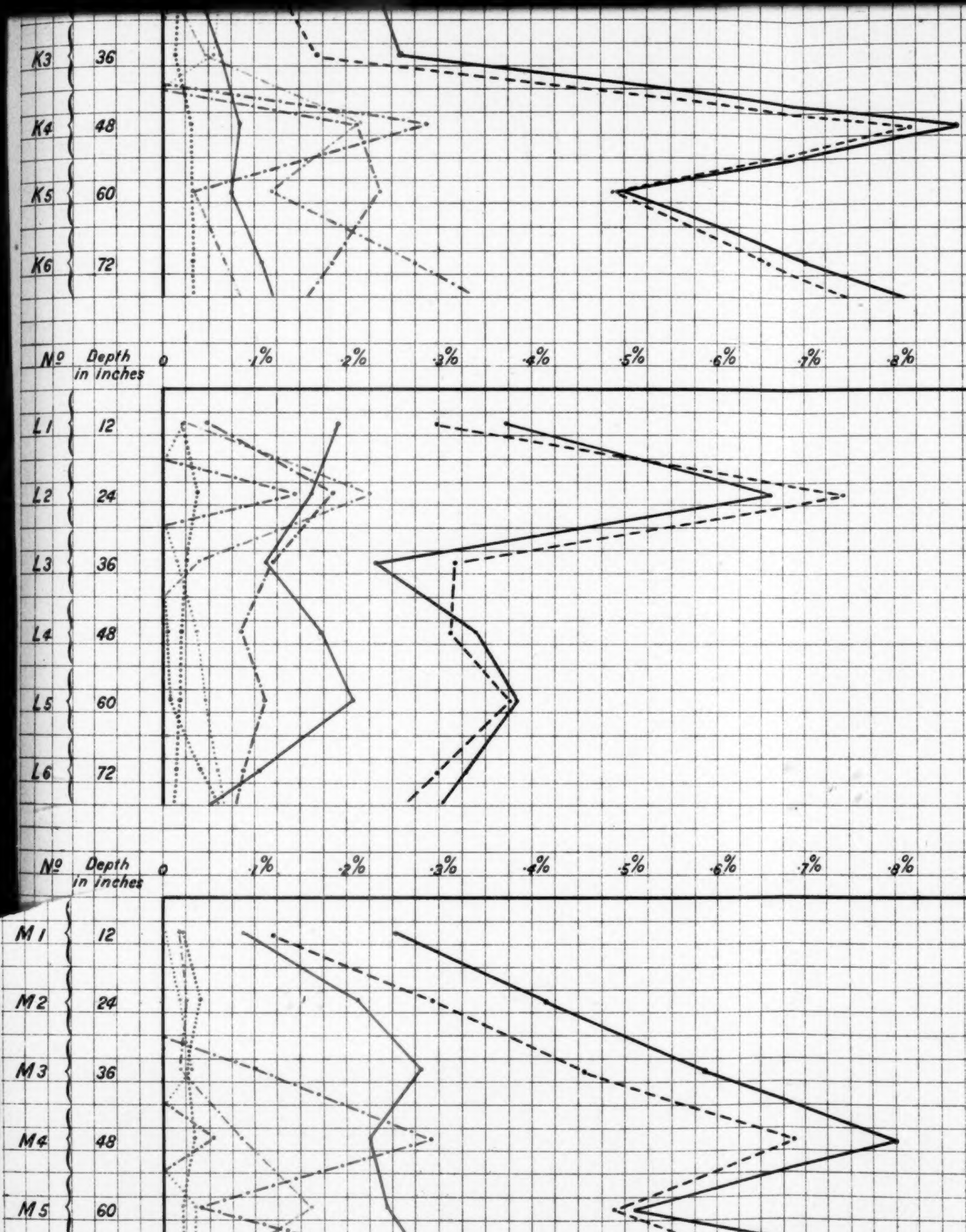
Diagram illustrating
Nº
Depth in inches
0
·1%
·2%
·3%
·4%
·5%
·6%
·7%
·8%
K1
12
K2
24
K3
36
K4
48
K5
60
K6
72
L1
12
L2
24
L3
36
L4
48
L5
60
L6
72
M1
12
M2
24
M3
36



llustrating soil alkalinity at Thebus Sleynsburg Division.
·8% ·9% 1·0% 1·1% 1·2% 1·3% 1·4% 1·5% 1·6% 1·7% 1·8%
Explanation
Total soluble salts (found)
" " " (calculated)
Sodium chloride
" sulphate
" carbonate
Magnesium chloride
" sulphate
" carbonate
Calcium chloride
" sulphate
" carbonate
·8% ·9% 1·0% 1·1% 1·2% 1·3% 1·4% 1·5% 1·6% 1·7% 1·8%
·8% ·9% 1·0% 1·1% 1·2% 1·3% 1·4% 1·5% 1·6% 1·7% 1·8%

Plate XVI.


ion.
1·5% 1·6% 1·7% 1·8% 1·9% 2·0% 2·1% 2·2%
Explanation
Total soluble salts (found)
" " " (calculated)
Sodium chloride
" sulphate
" carbonate
Magnesium chloride
" sulphate
" carbonate
Calcium chloride
" sulphate
" carbonate
1·5% 1·6% 1·7% 1·8% 1·9% 2·0% 2·1% 2·2%
1·5% 1·6% 1·7% 1·8% 1·9% 2·0% 2·1% 2·2%


K3 36
K4 48
K5 60
K6 72
Nº
Depth in inches
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L1 12
L2 24
L3 36
L4 48
L5 60
L6 72
Nº
Depth in inches
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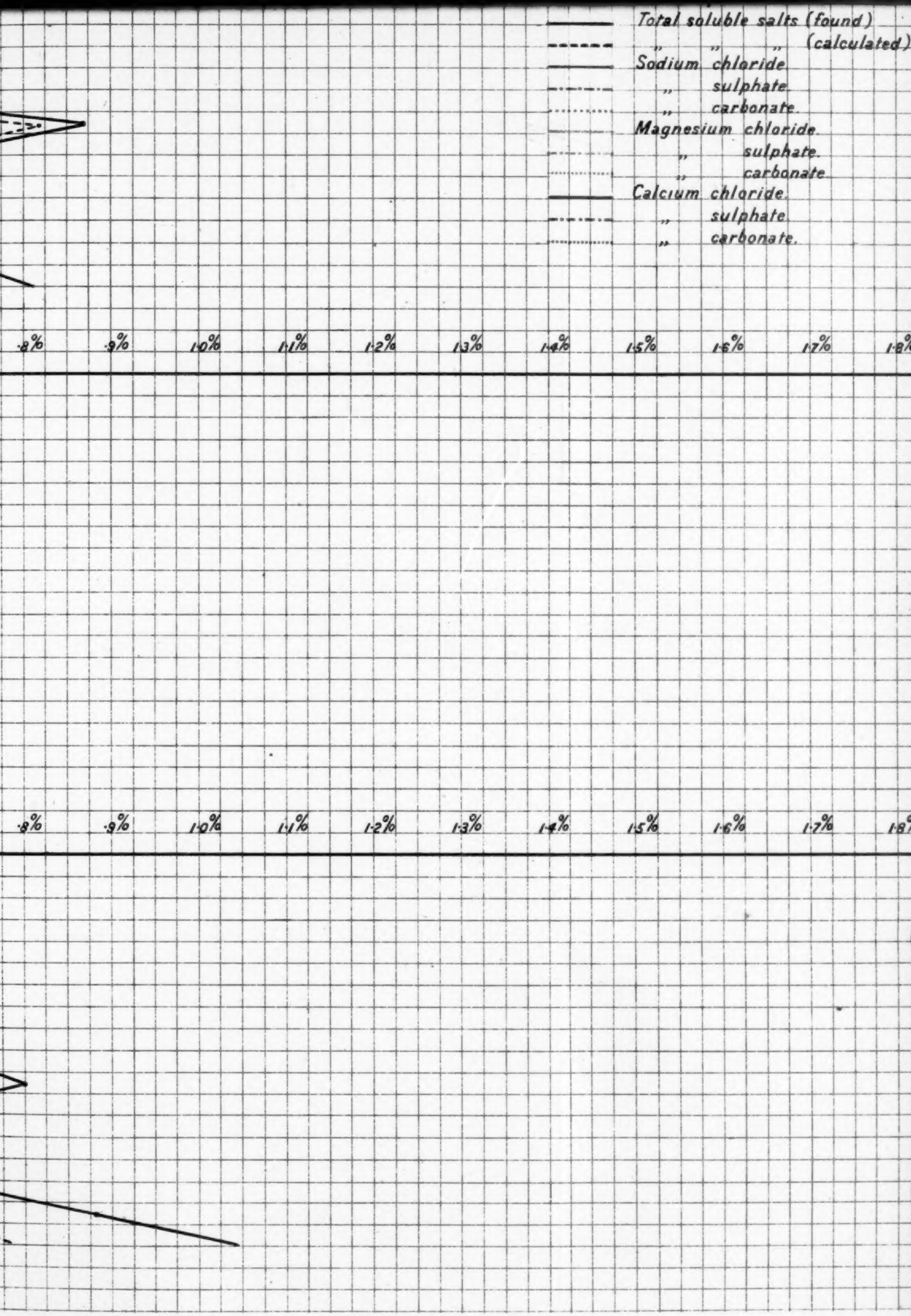
M1 12
M2 24
M3 36
M4 48
M5 60
M6 72


Total soluble salts (found)
" " " (calculated)
Sodium chloride.
" sulphate.
" carbonate.
Magnesium chloride.
" sulphate.
" carbonate.
Calcium chloride.
" sulphate.
" carbonate.
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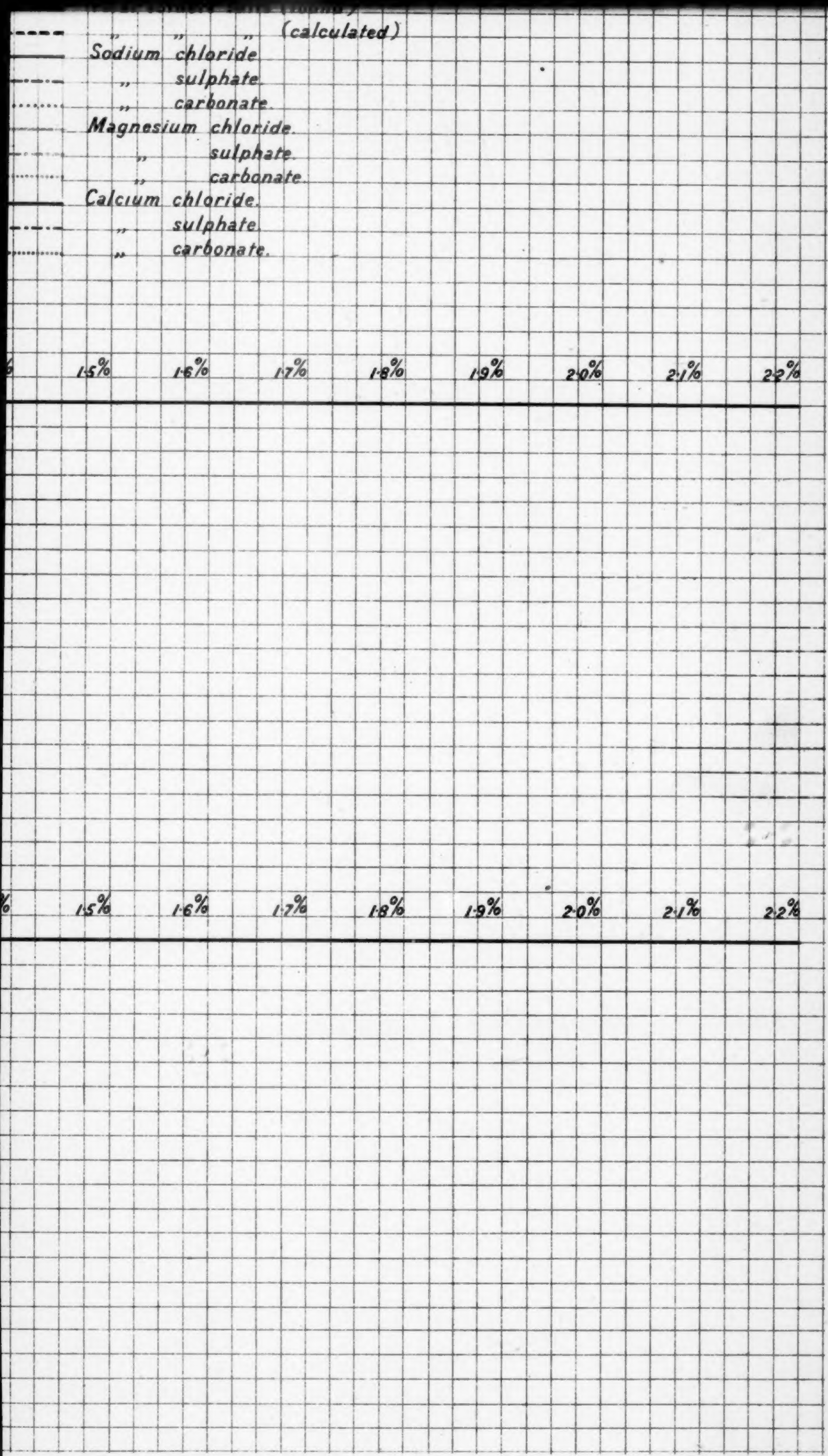

West, Newman lith.

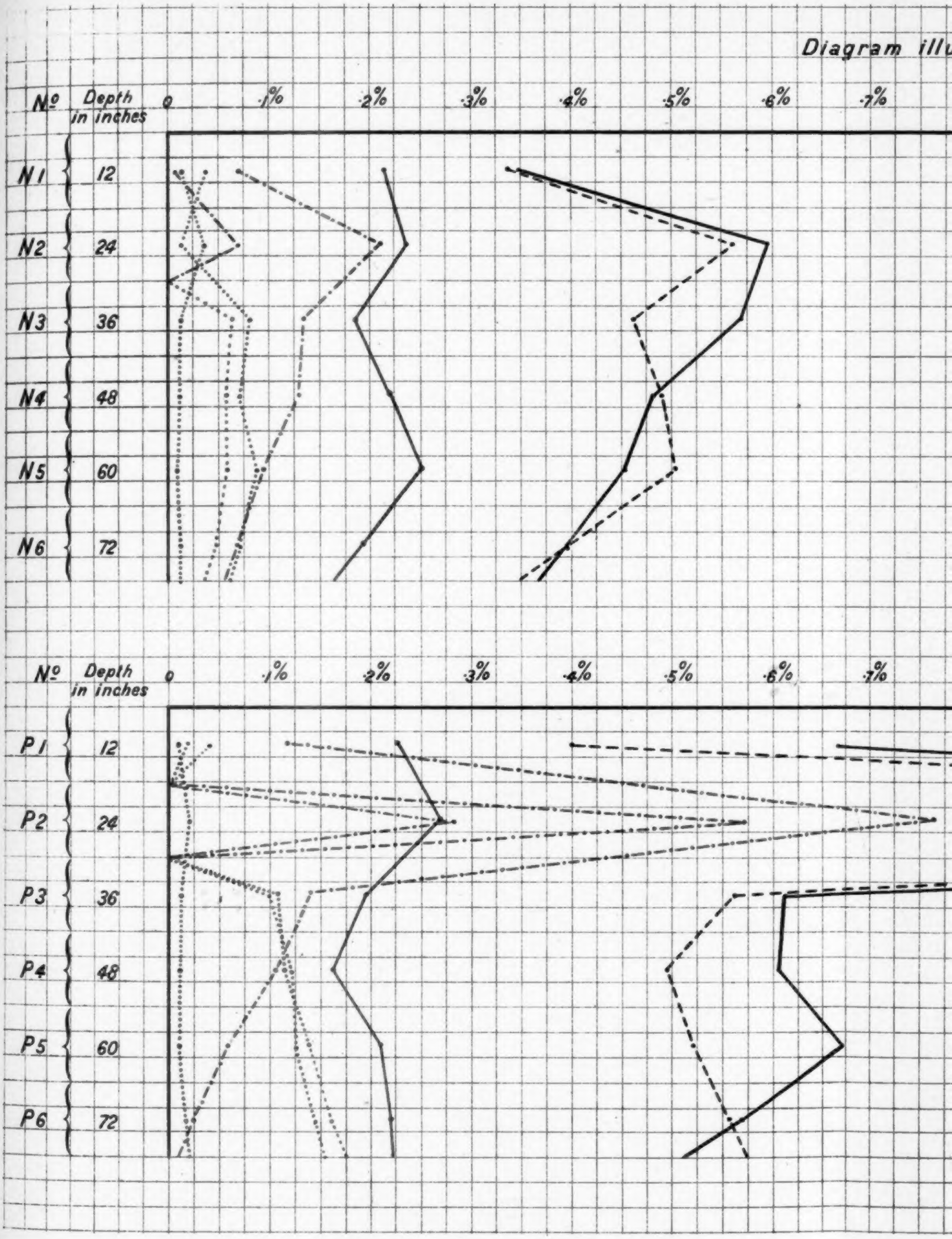
Diagram illu
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Depth in inches
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P4
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P5
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72

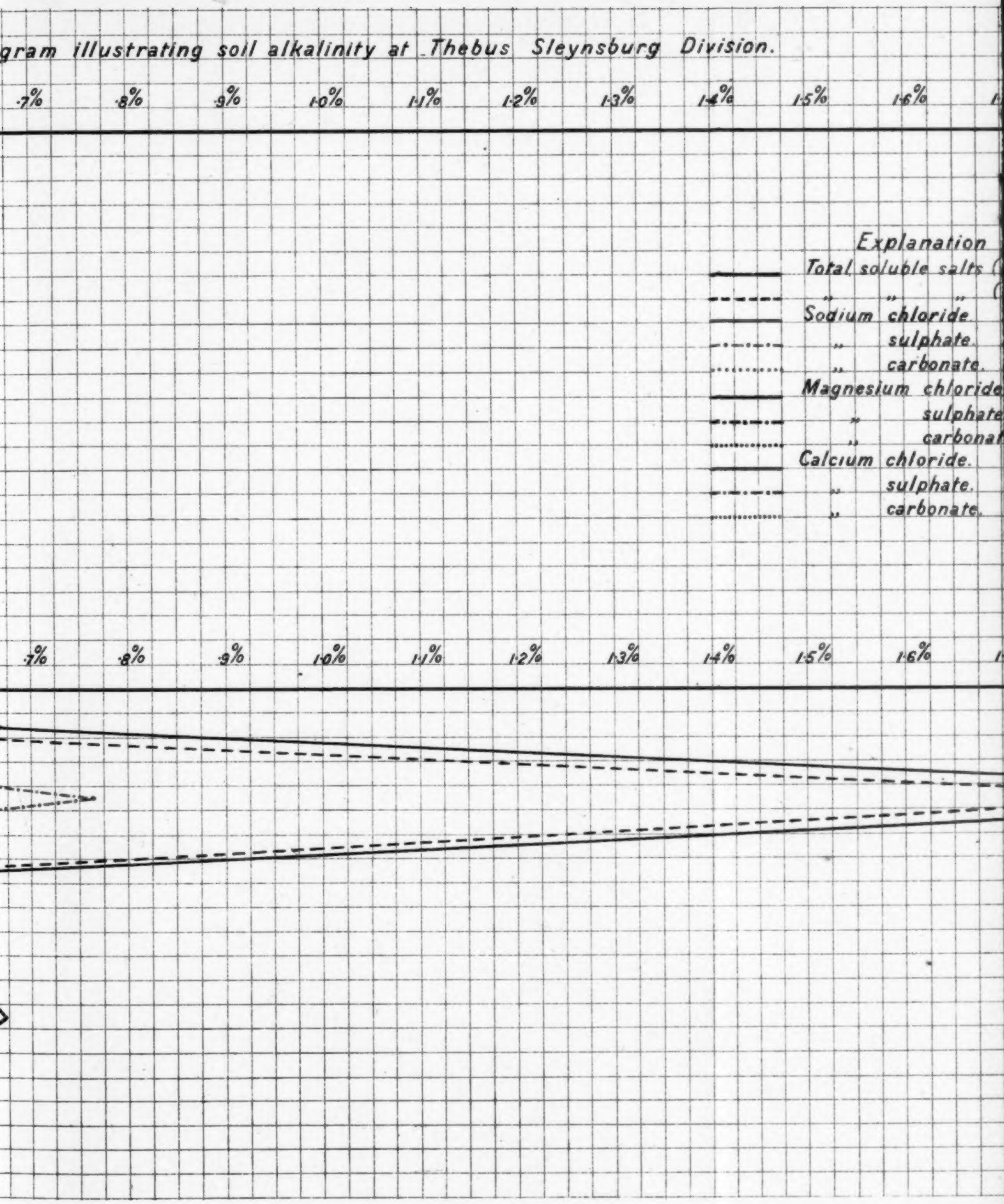
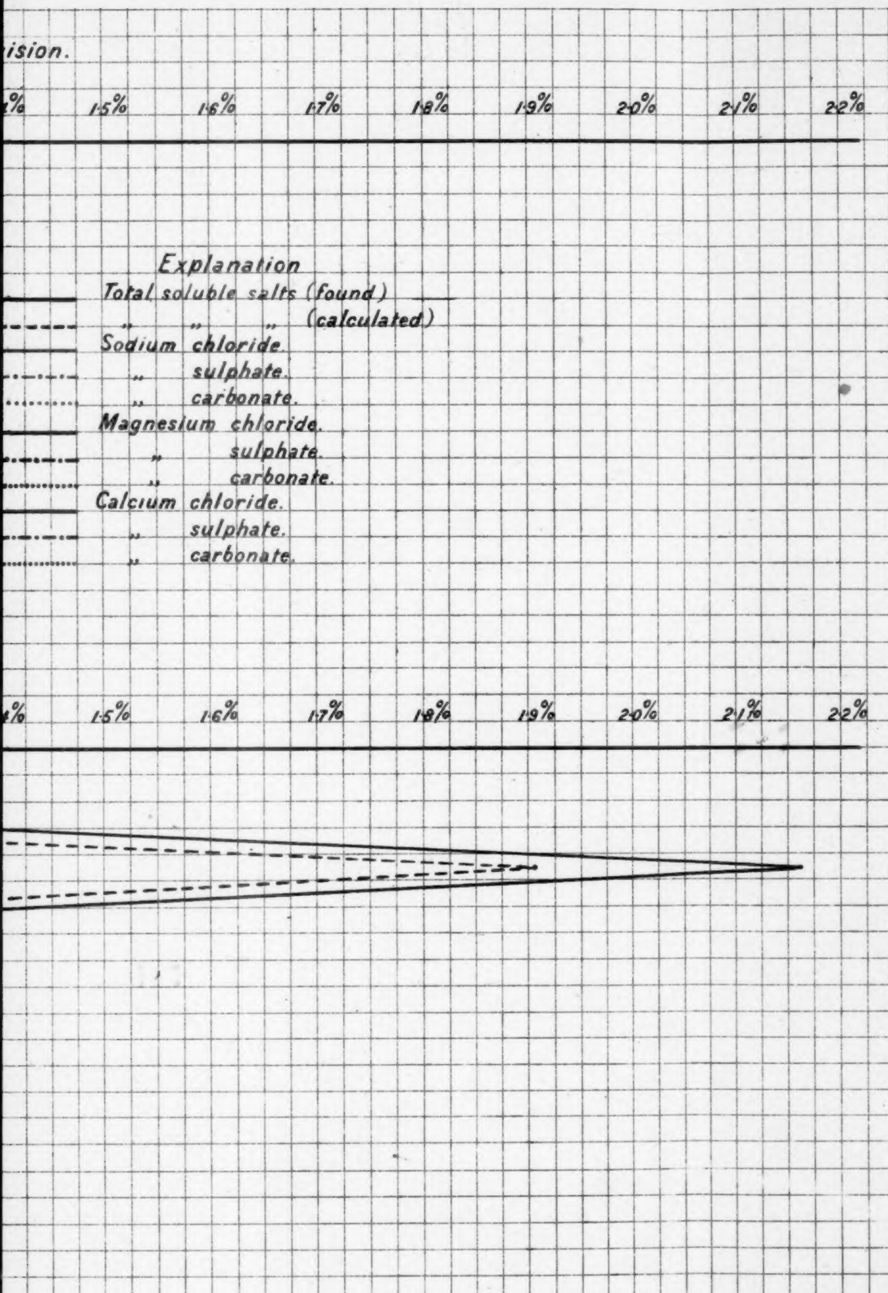

gram illustrating soil alkalinity at Thebus Sleynsburg Division.
·7% ·8% ·9% 1·0% 1·1% 1·2% 1·3% 1·4% 1·5% 1·6%
Explanation
Total soluble salts
Sodium chloride.
„ sulphate.
„ carbonate.
Magnesium chloride
„ sulphate
„ carbona
Calcium chloride.
„ sulphate.
„ carbonate.
·7% ·8% ·9% 1·0% 1·1% 1·2% 1·3% 1·4% 1·5% 1·6%

Plate XVII.



West, Newman lith.

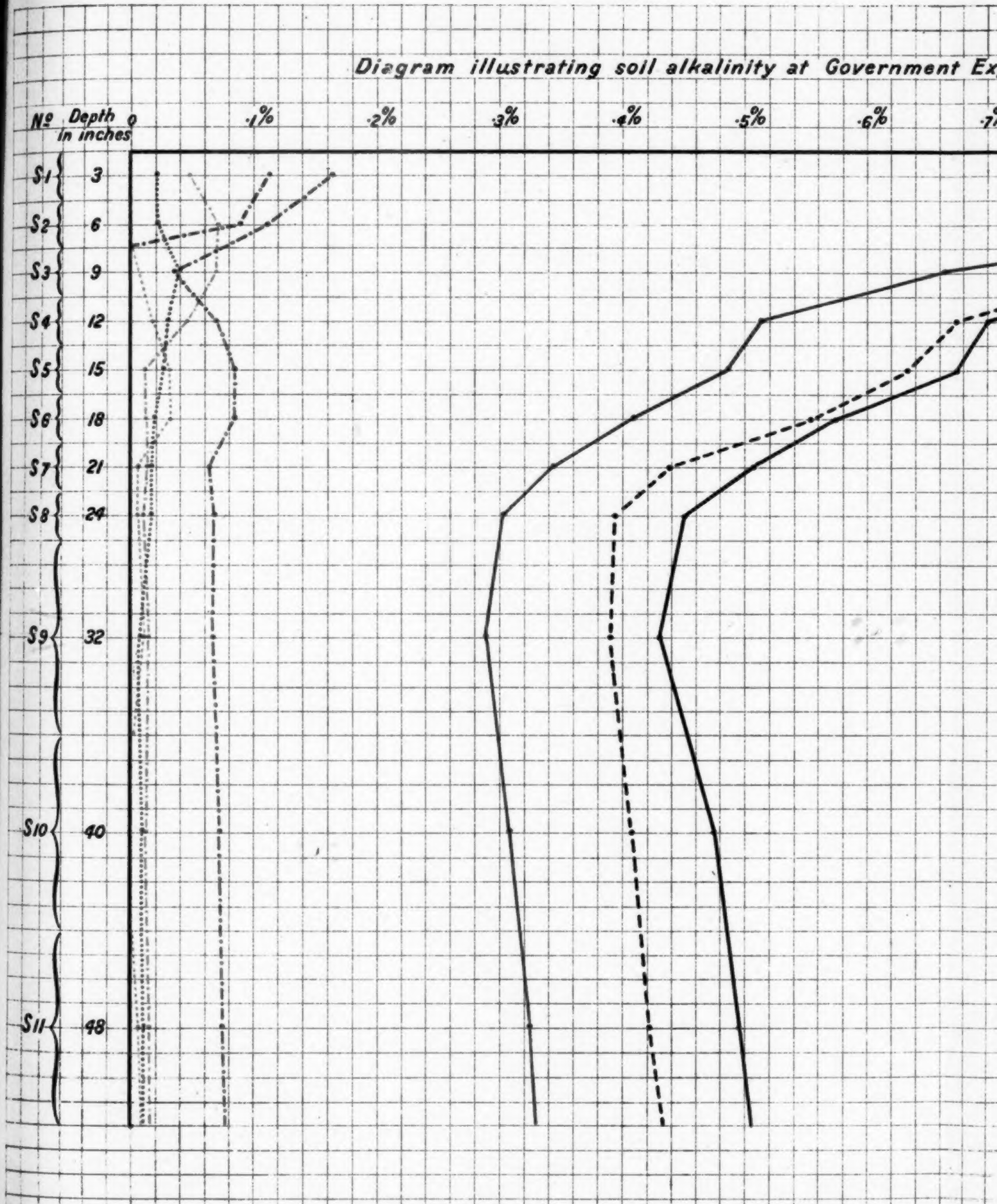


Diagram illustrating soil alkalinity at Government Ex
Nº
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S8
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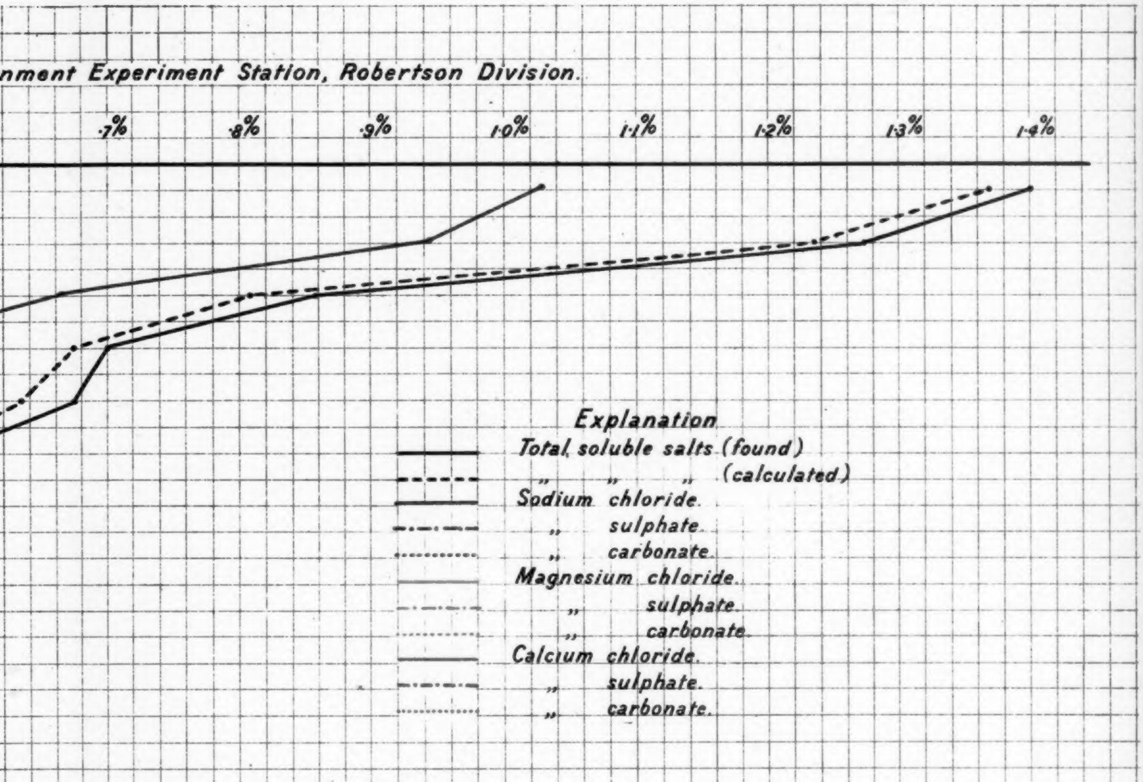
S9
32
S10
40
S11
48

Plate XVII



West, Newman lith.

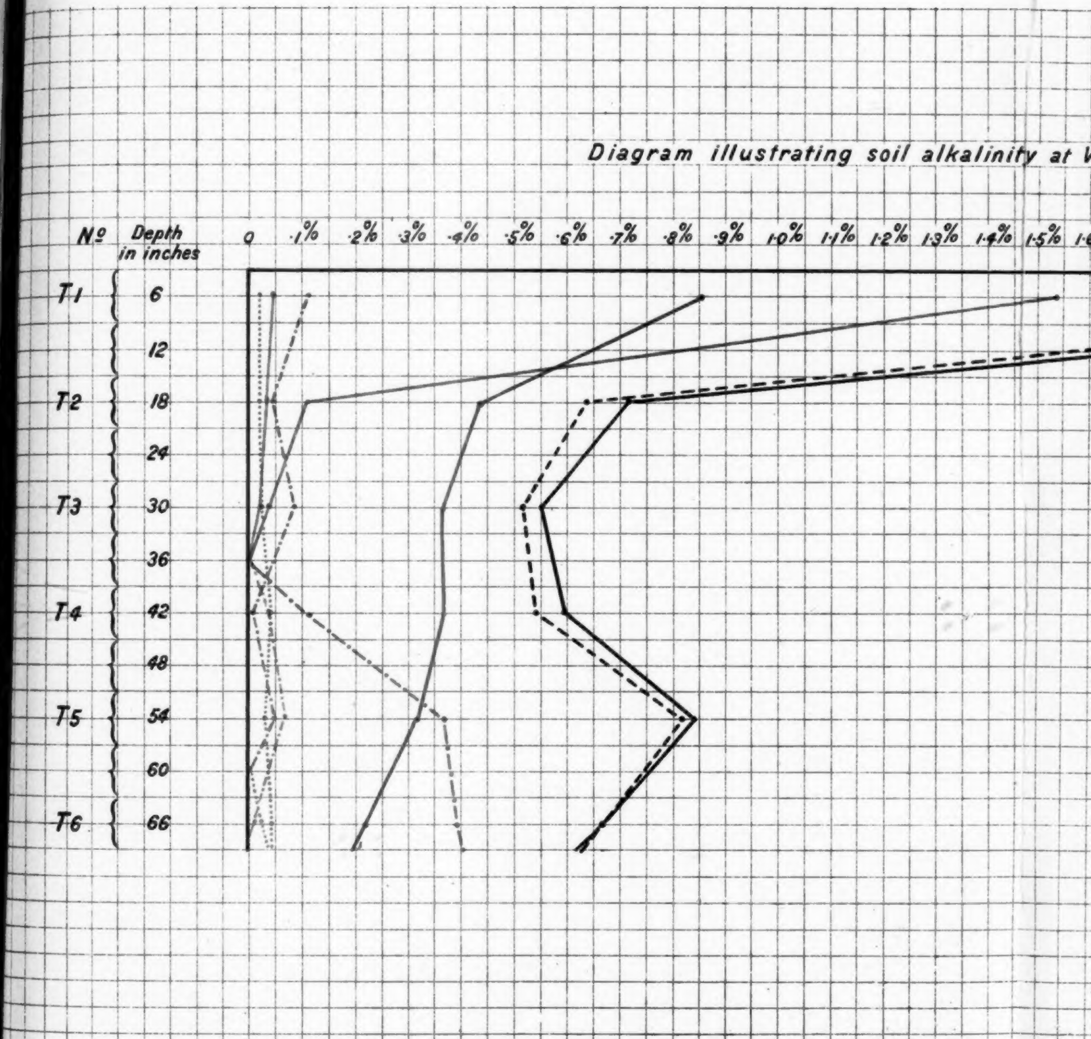


Diagram illustrating soil alkalinity at W
Nº
Depth in inches
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·2%
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T1
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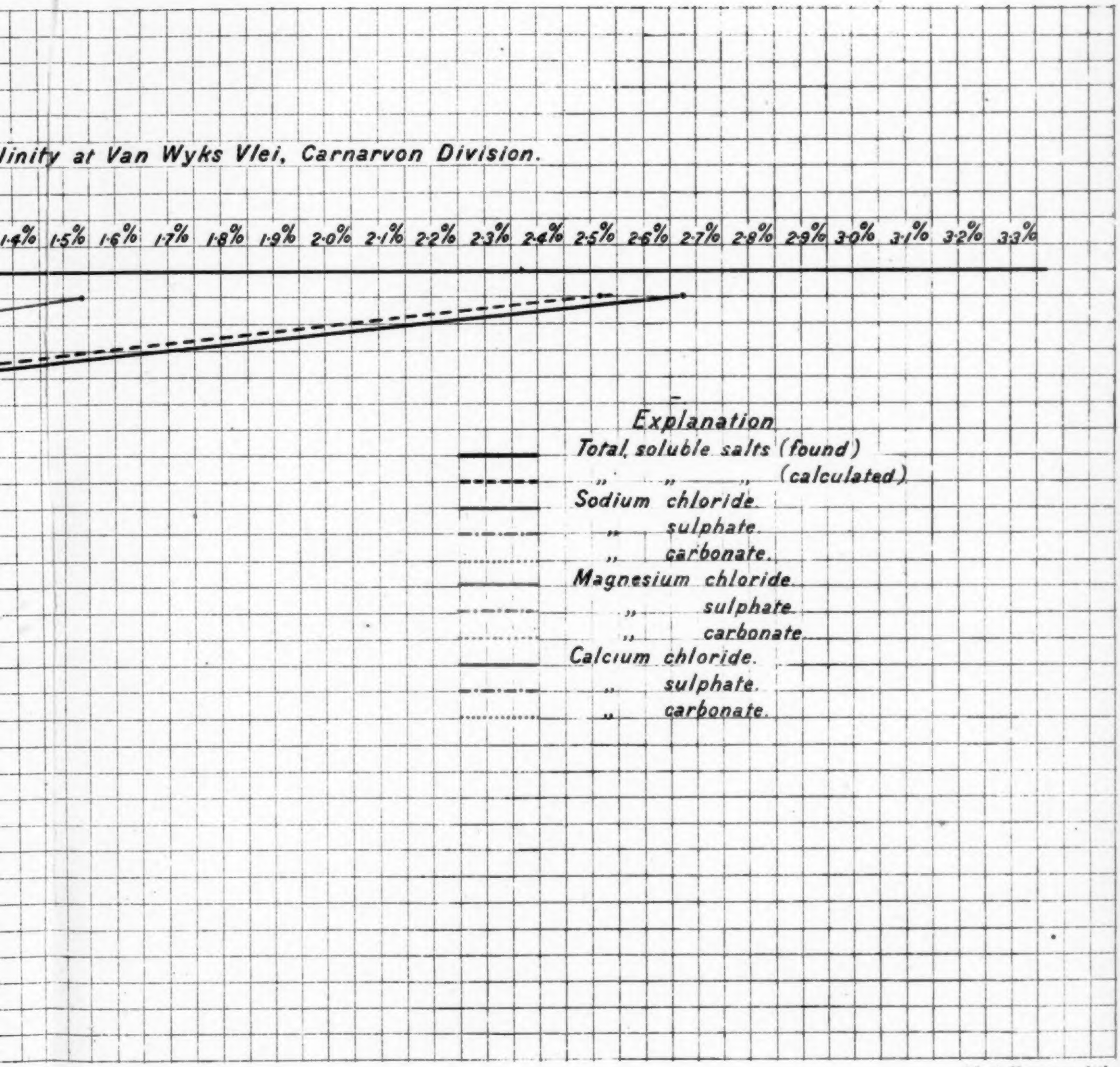
42
48
54
60
66



West, Newman lith.

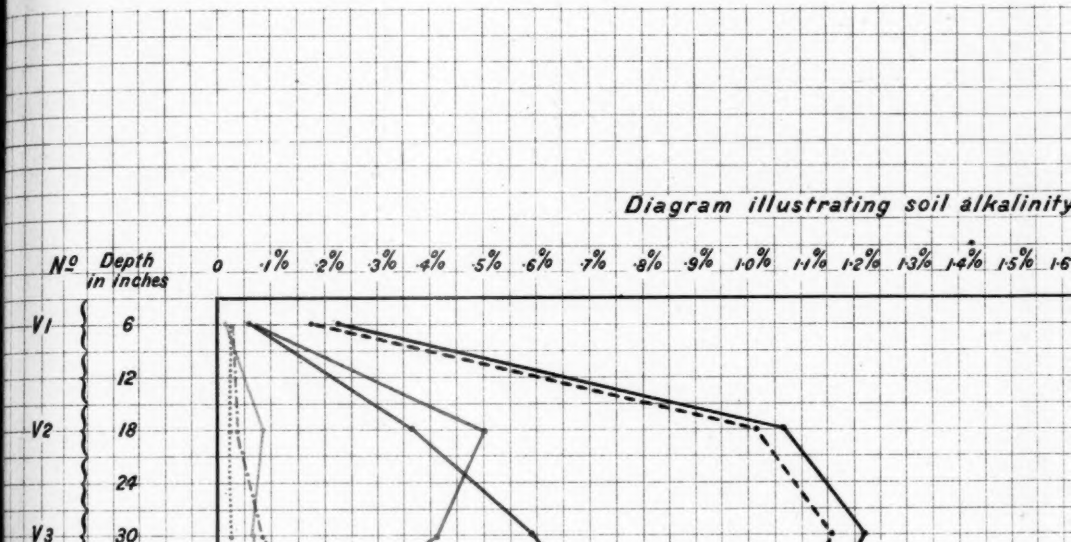


Diagram illustrating soil alkalinity
Nº
Depth in inches
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·1%
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V1
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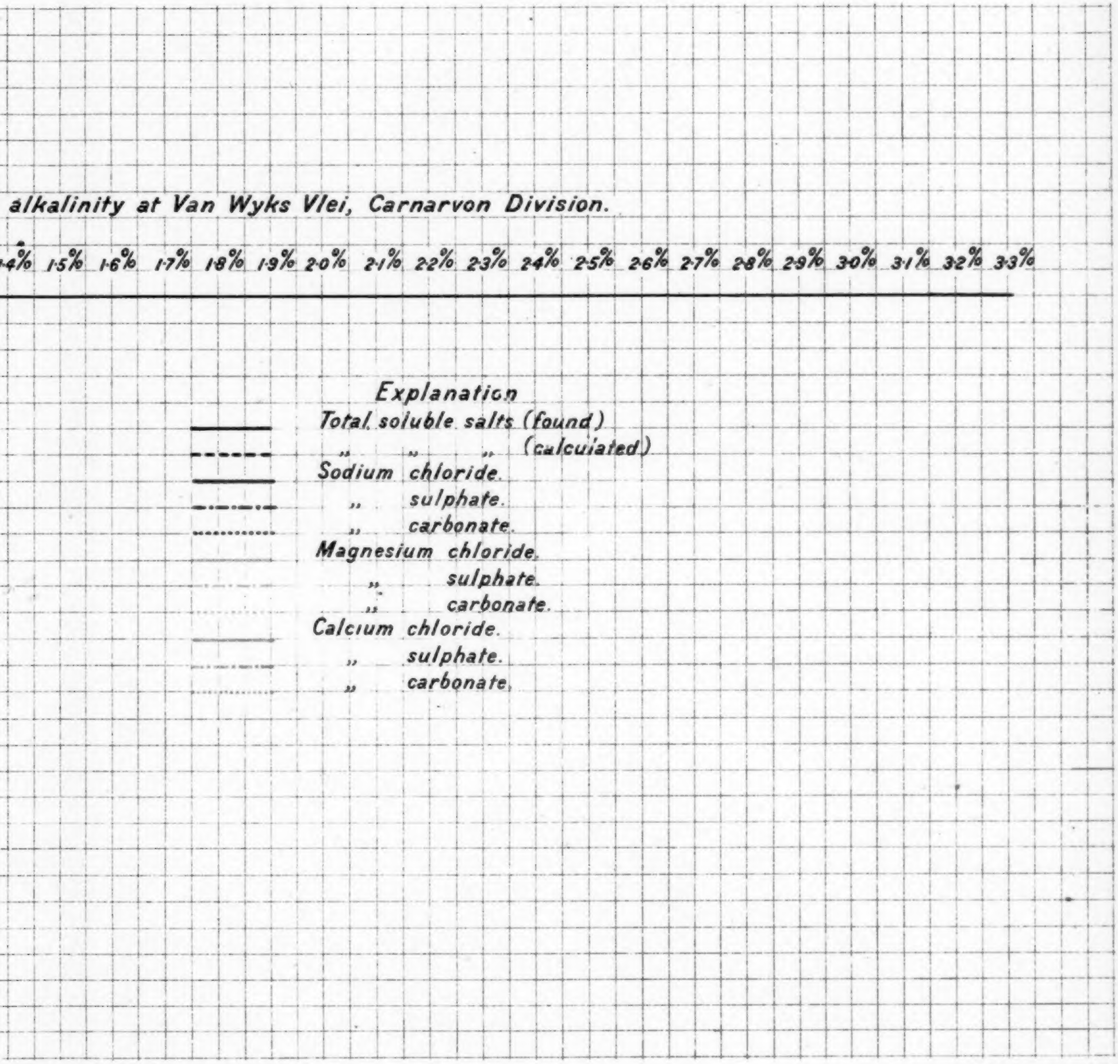
Plate XX.



West, Newman lith.

CONTRIBUTIONS TO THE AFRICAN FLORA.

By Harry Bolus, D.Sc., F.L.S., and Louisa Kensit, B.A.

(Plate XXI.).

Lotononis uniflora, Kensit, n. sp. (Leguminosæ-Genisteæ), ? § Krebsia.

L. undique canescenti- vel fulvo-pilosa; foliolis linearibus utrinque paullo angustatis; floribus erectis solitariis pedunculatis, pedunculis rigide patentibus foliis oppositis.

Herba gracilis undique petalis exceptis canescenti- vel fulvo-pilosa 15–25 cm. alta; rami erecti teretes gracillimi, internodiis 1·3–2 cm. longis; folia erecta alterna petiolata, petiolo 0·8–1·5 cm. longo, stipulis binis setaceis 0·4 cm. longis, 3-foliolata, foliolis linearibus utrinque paullo angustatis, intermediis longioribus, 1–2·2 cm. longis, 0·2–0·4 cm. latis; flores erecti lutei solitarii pedunculati, pedunculis rigide patentibus foliis oppositis apice articulatis, 2–3-bracteolatis, 1–1·7 cm. longis; calyx 1 cm. longus, segmentis lanceolatis acuminatis 0·5–0·6 cm. longis; vexillum brevissime unguiculatum, lamina ovali 1·4 cm. longa, 0·7 cm. lata; alæ obovato-oblongæ breviter unguiculatæ 1·3 cm. longæ; carina subovata obtusa 1 cm. longa; ovarium marginibus et apice dense sericeum pluri-ovulatum 0·5 cm. longum; stylus rectus glaber 0·3 cm. longus; legumen lineare acutum subturgidum 2·5 cm. longum.

Hab.: Transvaal Colony; Rustenburg, approx. alt. 1,350 metres, Jan., *Olive Nation*, 315!; Maxalaquena River, approx. alt. 1,275 metres, Jan., *R. Schlechter*, 4280.

This seems very distinct in the genus. The slender peduncle, spreading stiffly at a right angle and articulate near the apex, resembles that of *L. genuflexa*, Benth., but in every other respect the two species are quite different. The narrow vexillum and the very slender habit of the plant make its position in the § Krebsia somewhat doubtful.

L. Rogersii, Kensit, n. sp.

L. foliolis linearibus spinescenti-mucronatis; floribus in spicis 3–4 fl. axillaribus et terminalibus dispositis; stylo recto.

Fruticulus ramis erectis, teretibus, glabris, ad 26 cm. altus; folia sessilia vel brevissime petiolata, alterna, exstipulata, 3-foliolata, foliolis

linearibus basin versus angustatis acutis spinescenti-mucronatis complicatis vel marginibus valde involutis, glabris, junioribus sericeis, intermediis 1·3–1·9 cm., lateralibus 0·7–1 cm. longis, 0·15 cm. latis; flores in spicis 3–4 fl. breviter pedunculatis axillaribus et terminalibus dispositi; bracteæ late obovatæ, sericeæ, mucronatæ, 0·3 cm. longæ, 0·25 cm. latæ; calyx subinflatus, sericeus 0·8 cm. longus, segmentis subulatis parvis, inferiore 0·25 cm. longo; vexillum obovatum breviter unguiculatum infra subsericeum 1 cm. longum, 0·7 cm. latum; alæ spathulato-obovatæ 1 cm. longæ, unguibus 0·5 cm. longis; carina obtusa 0·7 cm. longa, 0·15 cm. lata; ovarium pluri-ovulatum oblongum sericeo-villosum 0·5 cm. longum; stylus rectus 0·2 cm. longus; legumen ignotum.

Hab: Transvaal; Low Veldt, Rivulets, June, 1905, *Rev. F. A. Rogers*, 430!

This appears to be a very distinct species. The flowers have the aspect of those of *L. swaziensis*, Bolus, and *L. multiflora*, Schinz., but the calyx segments are different.

L. lenticula, Benth., var. γ, biflora, Kensit, nov. var.

Rami decumbentes elongati laxe foliati ad 30 cm. longi; petioli ad 0·5 cm. longi; foliola obovato-oblonga, intermediis ad 1·3 cm. lateralibus 0·8–1 cm. longis; flores bini majores; legumen paullo incurvum 1·3 cm. longum, 0·5 cm. latum, seminibus 13–15.

Hab.: Orange River Colony; Orange River, near Bethulie, approx. alt. 1,200 metres, Dec., *H. G. Flanagan*, 1496! (in herb. Bolus).

At first sight this appeared specifically distinct from *L. lenticula*, from which it looks very different on account of its long branches, larger leaves with shorter petioles, larger 2-nate flowers, and larger legumes. It seems better, however, to regard it as a more luxuriant var. of that species.

Dichilus pilosus, Kensit, n. sp.

D. gracili, E. & Z., affinis sed idumento piloso, foliis interdum 4–5 *foliolatis, floribus majoribus vexillo carinam æquante differt.*

Herba gracilis undique petalis exceptis canescenti-pilosa; rami adscendentes filiformes, internodiis 1–3·5 cm. longis; folia patentia alterna petiolata, petiolo 0·6–0·9 cm. longo, stipulis subulatis minutis deciduis, 3- vel interdum 4–5-foliolata, foliolis obovatis basi cuneatis mucronulatis conduplicatis, 1–1·2 cm. longis, 0·4–0·5 cm. latis; flores solitarii vel bini pedunculati, pedunculis foliis oppositis 0·8 cm. longis, bracteolis setaceis; calycis tubus vix 0·2 cm. longus, segmentis 4 lanceolatis setaceo-acuminatis infimo setaceo 0·6 cm. longis; vexillum unguiculatum 1 cm. longum, lamina suborbiculari 0·7 cm. longa, 0·6 cm. lata; alæ oblongæ apice rotundatæ 0·9 cm. longæ, 0·3 cm. latæ; carina obtusissima

vexillum æquans; ovarium sericeum pluri-ovulatum; legumen lineare acutum torulosum 6-spermum, 3·2 cm. longum, 0·35 cm. latum.

HAB.: Transvaal Colony; near Johannesburg, approx. alt. 1,800 metres, Dec., *Winifred Tucker* (in herb. Bolus, 11059 !).

LESSERTIA STRICTA, Bolus, n. sp. (Galegeæ).

L. foliis breviter petiolatis vel subsessilibus, foliolis superne glabris subtus strigilloso-pubescentibus; legumine vix inflato oblongo glabro 8–10 *spermo.*

Fruticulus perennis ramosus ad 40 cm. altus; caulis erectus strictus cum ramis subangulatus striatus pallidus glaberrimus; rami alterni adscendentes, internodiis 1·5–6 cm. longis; folia erecto-patentia alterna 4–8-juga 2–6 cm. longa, petiolo ad 0·3 cm. longo foliolis vulgo oppositis rarissime alternis oblongis obtusis vel obtusissimis mucronulatis superne glabris subtus strigilloso-pubescentibus prominenter nervosisque 0·7–1·5 cm. longis, 0·3–0·5 cm. latis, stipulis subulatis acuminatis ad 0·5 cm. longis; pedunculi subrigidi glabri 6·5–14 cm. longi, parte florifera 3·6 cm. longa; flores dissiti sæpius solitarii rarius 2–3-ni c^{a} 0·7 cm. longi; pedicelli patentes demum decurvi 0·4–0·7 cm. longi; calyx puberulus 0·3–0·4 cm. longus; legumen vix inflatum oblongum apiculatum glabrum 8–10 spermum, 2–3 cm. longum, 0·7–0·9 cm. latum.

HAB.: Cape Colony: Griqualand East, near Clydesdale, streams and moist meadows, c^{a} 800 metres, fl. Jan., *Tyson*, 2527 ! Natal: Weenen County, 1,200 metres, *Wood*, 3545 ! Van Reenen, 1,500–1,800 metres, Jan., *Wood*, 8846 ! Transvaal: Crocodile R., 1,500 metres, Dec., *Schlechter*, 3898 ! near Amersfoort, April, *Burtt-Davy*, April (in fruit), 4035 ! Scheerpoort, Feb. (in fruit), *Miss Leendertz*, 757 !—Mr. N. E. Brown has also kindly communicated the following collections in the Kew herb., which I have not seen, as being identical with Tyson's 2527, viz.: *Wood*, 3546; *Rehmann*, 7014; *Cooper*, 2218.

Lessertia, as remarked by Harvey, is undoubtedly a difficult genus to deal with, the species in many cases varying considerably. Although this is certainly allied to *L. perennans*, yet there are decided differences which are based upon an examination of a number of excellent specimens of both species. They may be briefly stated as follows :—

(1) The indumentum of the present species is shorter and more appressed (strigillose).

(2) The flowers are more laxly racemose.

(3) The stipules are smaller.

(4) The legumes are larger and especially longer and with more numerous seeds (8–10).

(5) The leaflets are glabrous above and strigillose only below.

MESEMBRIANTHEMUM CRYPTOPODIUM, Kensit, n. sp.
(Ficoideæ-Mesembrieæ), (Epapulosa, § Sphæroidea).
Plate XXI., figs. C, 6–7.

M. corpusculis late ovatis vel orbicularibus lateraliter subcompressis epunctatis viridibus; floribus pedunculatis pedunculis inclusis ad 2 cm. longis; petala rosea; stylis 6.

Corpuscula late ovata vel orbicularia lateraliter subcompressa brevissime pubescentia vel glabra 2–3 cm. longa; folia subæqualia subacuta parte libera 0·4–0·7 cm. longa; flores pedunculati, pedunculis compressis in corpusculis inclusis ad 2 cm. longis; calyx in pedunculum attenuatus exsertus, segmentis 6 oblongis obtusis 0·5 cm. longis; petala 2-seriata obtusa basi attenuata et breviter connata rosea vittata 1·2 cm. longa; glandulæ 6 semi-orbicularia atro-viridia; ovarium supra convexum 0·25 cm. diam., stylis 6 erectis filiformibus.

HAB.: Between Wittepoort (Worcester Div.) and Laingsburg (Prince Albert Div.), approx. alt. 690 metres, fl. June, *N. S. Pillans*, 892! (in herb. Bolus).

A distinct species with something of the habit of the § *Gibbosa*, except that the leaves are almost equal in size and united for nearly their whole length. In the § *Sphæroidea* it is easily distinguished by its somewhat acute leaves not united quite to the apex, and the pedunculate flowers.

Plate XXI. C, fig. 6, one of the largest corpusculums, showing a portion of the underground stem; 7, peduncle and gynæcium.

M. RETROVERSUM, Kensit, n. sp.
Plate XXI., figs. A, 1–4.

M. foliis duobus æqualibus, basi et altero latere dimidio longitudinis marginibus connatis, altero latere marginibus liberis; floribus sessilibus; petalis roseo-purpureis; stylis 7, *filiformibus.*

Radices gracillimi fibrosi numerosi; caudex fere nullus; rami brevissimi densi reliquiis foliorum delapsorum onusti; folia 2, basi et altero latere dimidio longitudinis marginibus connatis, altero latere marginibus liberis, subexpansa obtusa supra planiuscula vel sæpe subsulcata dorso convexiuscula glaberrima viridia paucis pellucidis punctis sparsa 2–2·4 cm., longa 0·7–0·9 cm., lata 0·5 cm. diam.; flores sessiles foliis cincti; calyx subglobosus 0·7 cm. diam., segmentis 7 inter se inæqualissimis, exterioribus acutis 0·5 cm. longis, interioribus late membranaceo-marginatis 0·2–0·3 cm. longis; petala 2–3-seriata linearia roseo-purpurea 0·7 cm. longa, 0·1 cm. lata; stamina staminodiaque numerosa ad 0·4 cm. longa; ovarium supra planum 0·4 cm. diam.; stylis 7, filiformibus erectis 0·4 cm. longis.

HAB.: Cape Colony; distr. Piquetberg, near Eendekuil, approx. alt. 90 metres, fl. July, *N. S. Pillans*, 955! (in herb. Bolus).

A very curious and interesting little plant which does not fit well into any of the existing sections. It has the two leaves with the solitary central flower of the § Sphæroidea, but the leaves do not form fleshy corpuscula. Connate at base and for about half or a little more of their length on one side, on the other side they are free and spread out in a fan-like manner at the apex, embracing the sessile flower at the base.

Plate XXI. A, fig. 1, flower; 2, gynæcium; 3, pair of leaves viewed dorsally; 4, the same viewed laterally.

M. DIVERGENS, Kensit, n. sp. (§ 2 Subquadrifolia).

M. foliis patentibus vaginato-connatis obtusissimis; floribus solitariis breviter pedunculatis; petalis purpureis; stylis 6 *linearibus longe acuminatis.*

Herba subacaulescens ramosa ad 7 cm. alta; rami breves sæpissime 4-foliati; folia divergentia vaginato-connata triquetra oblonga obtusissima integerrima epunctata viridia 3·5–5 cm. longa, 1–1·2 cm. crassa (ab angulo laterali ad angulum carinalem metiente): flores solitarii breviter pedunculati, pedunculis 2-bracteatis 1·8 cm. longis; calyx in pedunculum attenuatus, segmentis oblongis obtusis inter se subæqualibus 1 cm. longis; petala 2-seriata linearia basin versus angustata apice emarginata inter se subæquilonga purpurea 3 cm. longa, 0·2 cm. lata; stamina omnia fertilia, filamentis albis 0·5–0·7 cm. longis; ovarium supra convexum 0·5 cm. diam., stylis 6 linearibus longe acuminatis ultra stamina exsertis 0·8 cm. longis.

HAB.: Cape Colony, Matjesfontein, fl. July, *N. S. Pillans*, 949! (in herb. Bolus).

This is near *M. brevipes*, Schltr., but differs in having triquetrous leaves which are usually shorter than in that species, longer calyx segments, longer petals, and slender styles exceeding the stamens.

M. INTRUSUM, Kensit, n. sp. (§ 2 Subquadrifolia).

M. e basi ramulosum; ramis brevibus 2–4-*foliatis; foliis basi connatis turgido-triquetris obtusis; floribus solitariis pedunculatis pedunculis ad* 4 *cm. longis; calyce basi leviter intruso; petalis purpureis; ovario supra semi-globosum; stylis* 5 *subulatis erectis.*

Herba humilis 6–7 cm. alta e basi ramulosa; rami robusti breves vaginis foliorum delapsorum onusti, ramulis 2–4-foliatis; folia basi connata turgido-triquetra obtusa integerrima vel rarius apice leviter 2-loba subglauca vel viridia transverse tenuiter albo-lineata inæqualia ad 5·5 cm. longa, 0·9 cm. diam.; flores solitarii ad 4 cm. diam. pedunculati, pedunculis gracilibus teretibus basi 2-bracteatis ad 4 cm. longis; calyx basi truncatus leviter intrususque politus 0·8 cm. diam., segmentis subovatis inter se subæqualibus ca 0·6 cm. longis; petala 1-seriata subobtusa purpurea

1·7 cm. longa; stamina omnia fertilia convergentia; ovarium supra semi-globosum, 0·7 cm. diam., stylis 5-subulatis erectis, 0·2 cm. longis.

HAB.: Cape Colony, hills near Robertson, approx. alt. 240 metres, fl. July, *L. Kensit* (in herb. Bolus, 6500!); *R. Marloth*, 4592.

Near *M. brevipes*, Schltr., and *M. divergens*, Kensit, but distinguished from both by the long slender peduncle and very peculiar truncate somewhat intruse calyx tube.

From the former it also differs in having 3-quetrous leaves; and from the latter in having longer and more slender leaves.

M. ROSULATUM, Kensit, n. sp. (? § 4 Aloidea).
Plate XXI., figs. B, 5.

M. acaule foliis late spathulatis planis; floribus 3-natis, breviter pedunculatis pedunculis basi 2-bracteatis; petalis aureis rubro-vittatis; ovario supra semi-globoso; stylis 11–12 filiformibus.

Acaulescens radice et caudice tuberosis c^a 3·5 cm. altum; folia 8–10 erecta demum patentia rosulata late spathulata basi connata griseo-brunnea permultis pallidioribus punctis adspersa, 2·5–3·2 cm. longa, 1·7–2·2 cm., 0·8–1 cm. lata; flores 3-nati breviter pedunculati, pedunculis 0·7–1·1 cm. longis, 2-bracteatis, bracteis ovato-lanceolatis, 0·9–1·2 cm. longis; calyx punctatus tubo brevissimo, segmentis triangularibus inter se subæqualibus, 0·7 cm. longis; petala sub-2-seriata, linearia acuta aurea rubro-vittata ad 0·9 cm. longa, 0·18 cm. lata; stamina omnia fertilia convergentia, 0·5 cm. longa; ovarium supra semi-globosum, stylis 11–12 erecto-patentibus, 0·3 cm. longis; capsula semi-globosa, 1·2 cm. diam.

HAB.: Cape Colony, Willowmore, fl. July, *E. Pillans* (in herb. *N. S. Pillans*, 1266!).

A very distinct species which may readily be known by its flat leaves. It seems best placed in the § Aloidea, from which, however, it differs in having 3-nate flowers and 11–12 styles. The flowers closely resemble those of *M. vittatum*, N. E. Br. The leaves are a greyish brown with tinges of red ($^c0_1$ in Prang's System of Colour is a very good match), and finally spread out, forming a rosette.

Plate XXI. B, fig. 5, gynæcium.

M. PACHYPODIUM, Kensit, n. sp. (§ 11 Teretifolia).

M. molliter pubescens foliis semi-teretibus vulgo acutis; floribus solitariis longe pedunculatis pedunculis ebracteatis crassis; calycis segmentis inter se inæqualissimis; stylis 6 erectis carnosis.

Herba subacaulis undique breviter et molliter griseo-pubescens; folia erecta demum patentia vaginato-connata semi-teretia apicem versus leviter carinata acuta vel rarius subobtusa inæqualia, majoribus 6–10 cm. longis, 0·8–1·4 cm. diam., minoribus 5·5–8 cm. longis, 0·5–1 cm. diam.;

flores solitarii longe pedunculati, pedunculis erectis subcompressis ebracteatis crassis basin versus attenuatis, 5·5–10 cm. longis, apice 0·5–0·8 cm. diam.; calyx gradatim in pedunculum attenuatus, segmentis 6 erectis e basi lata lanceolatis crassis inter se perinæqualibus exterioribus 2·7–4 cm. interioribus, 1·2 cm. longis; petala 3-seriata linearia dilute rosea basin versus alba ad 2 cm. longa, 0·15 cm. lata; glandes 6 distincti; stamina staminodiaque ∞; ovarium supra convexum 0·8 cm. diam., stylis 6 erectis subulatis carnosis 0·3 cm. longis.

HAB.: Cape Colony, between Muis Kraal and Ladismith, fl. Nov., *N. S. Pillans*, 898! (in herb. Bolus).

This has the ebracteate peduncle of the § Calamiformia, but the softer spreading leaves of the § Teretifolia. It is allied to *M. calamiforme*, Linn., and the little-known *M. teretifolium*, Haw., from both of which it is distinguished by its short, soft, close grey pubescence, 6 cleft calyx and 6 styles.

From the former it also differs in having the leaves acute, soft, and spreading, the peduncle longer and much thicker, and longer and thicker calyx segments.

M. MACROCALYX, Kensit, n. sp.

M. foliis erecto-incurvis compresso-triquetris acutis mucronulatis; calycis segmentis elongatis quam petala duplo-longioribus vel ultra; stylis 5–6 minutis carnosis.

Suffrutex glaberrimus glaucescens; rami decumbentes ramulis erectis compressis foliosis; folia subconnata erecto-incurva demum patentia compresso-triquetra acuta mucronulata angulis carinalibus minute serrulatis ad 5 cm. longa, 0·6 cm. crassa (ab angulo laterali ad angulum carinalem metiente); flores 3-nati pedunculati, pedunculis 1 cm. longis lateralibus ad apicem duabus bracteis foliaceis 3 cm. longis præditis; calyx turbinatus subcompressus, segmentis 5–6 inæqualibus lanceolatis longe acuminatis, longioribus carinatis, brevioribus basi fusco-membranaceo-marginatis, 1·5–2 cm. longis; petala sub-3-seriata linearia albida 0·7 cm. longa; ovarium supra planum 0·7 cm. diam.; styli 5–6 carnosi minuti vix 0·1 cm. longi; capsula turbinata 5–6 angulata, 1 cm. diam.

HAB.: Cape Colony, Skurf Kop, near Somerset West, *N. S. Pillans*, 1423! (in herb. Bolus).

M. LITORALE, Kensit, n. sp.

M. ramis elongatis prostratis vel diffusis non radicantibus; foliis triquetris valde lateraliter compressis acutis glaucis; floribus 3-natis, petalis albis; stylis 5 subulatis carnosis.

Herba diffusa glaberrima; rami decumbentes compressi graciles elongati pallidi ad 35 cm. longi, internodiis 2–4·5 cm. longis; folia subconnata

erecto-patentia juniora subfalcata triquetra lateraliter valde compressa angulis albo-marginatis, oblonga basin versus paullo angustata acuta mucronulata supra subplana glauca 2·5–3 cm. longa, 0·5–0·6 cm. crassa; flores 3-nati pedunculati, pedunculis 0·5–1·7 cm. longis, lateralibus 2-bracteatis; calyx subangulatus, segmentis 5–6 anguste lanceolatis acutis inter se subinæqualibus 0·5–1 cm. longis; petala pluriseriata, linearia alba, calycem æquantia staminibus duplo longiora; ovarium supra conicum, stylis 5 subulatis carnosis, 0·2 cm. longis.

HAB.: Cape Colony; Mossel Bay, on the sea coast near the town, Jan., *H. Bolus*, 8653! *F. Guthrie*, 4315! Nama'land, *N. S. Pillans*, 1424! Near Mierkraal, *R. Schlechter*, 10516!

M. APICULATUM, Kensit, n. sp. (§ 31 Forficata).

M. velutinum foliis patentibus vaginato-connatis triquetris subcompressis, angulis marginatis, apiculatis integerrimis; petalis spathulatis roseis.

Fruticulus ramosus fere undique griseo-velutinus ad 45 cm. altus; rami adscendentes 5–8 cm. longi; folia fere pro parte dimidia longitudinis vaginato-connata obtuse triquetra, angulis carinalibus subcompressis integerrimis, acuta apiculata marginata ciliolata 1·5–3 cm. longa, 0·6–0·9 cm. crassa; flores solitarii subsessiles; calyx subturbinatus 0·6 cm. longus, segmentis ovatis apiculatis subæqualibus 0·7 cm. longis; petala 3-seriata spathulata rosea basi alba, 1·1 cm. longa; ovarium supra concavum 0·5 cm. diam., stylis 5 erectis subulatis setaceo-acuminatis 0·45 cm. longis.

HAB.: Cape Colony; Clanwilliam Div., *C. L. Leipoldt*, 666! (in herb. Albany Museum); Doorn River, alt. c[a] 60 metres, fl. July, *R. Schlechter*, 8065! (in herbb. Albany Museum and Bolus); low ridges north-east of Matjesfontein, *N. S. Pillans*, 894! (in herb. Bolus).

This seems best placed in the § Forficata. From *M. forficatum* it is easily distinguished by the more crowded and more connate leaves without teeth on the carinal angle;, by the short soft pubescence; by the spathulate petals; and by the subulate acuminate styles.

M. RESURGENS, Kensit, n. sp. (Papulosa).

M. caudice tuberoso hieme plures caules breves dense foliosos emittente; foliis petiolatis teretibus; floribus solitariis ebracteatis; stylis 5 *erectis filiformibus.*

Herba humilis cæspitosa; caudex tuberosus apice 5 cm. latus; caules breves simplices erectæ e margine caudicis orientes ad 2 cm. longi, 0·5 cm. diam.; folia densa patentia flaccida teretia obtusa infra medium in petiolum paullo dilatatum rubescentem attenuata perviridia minute papillosa cum petiolo ad 6 cm. longa, 0·5 cm. diam.; flores terminales solitarii

pedicellati, pedicellis ebracteatis 0·8–1·2 cm. longis; calyx campanulatus, tubo obscure 5-angulato papillis viridibus nitente 0·9–1·1 cm. longo, segmentis obtusissimis minute papillosis inter se perinæqualibus 0·6–1·3 cm. longis; petala sub-4-seriata basi cum staminibus in tubum coalita erecto-patentia recurvata anguste linearia acuta vel acuminata dilute straminea 1–1·7 cm. longa vix 0·1 cm. lata; stamina petalis breviora inclusa; ovarium supra planiusculum, stylis 5 erectis conniventibus filiformibus 0·4 cm. longis.

HAB.: Cape Colony, Matjesfontein, fl. July, *N. S. Pillans*, 969! (in herb. Bolus); Calvinia Div., Onder-Bokkeveld, near Papelfontein, approx. alt. 660 metres, Aug., *Schlechter*, 10913! (in herb. Bolus, etc.); Clanwilliam, *Leipoldt*, 665! (in herb. Albany Museum).

Mr. N. S. Pillans informs me that the leaves of this very interesting species are deciduous in the summer, and that the plant finally dies down, leaving no trace of its existence above the ground until about May or June, when it sends up new shoots all round the root-stock.

It is quite unlike any other species hitherto described in the genus. The leaves are very crowded—a short stem bearing as many as 22—and spread limply, giving the plant a densely tufted appearance. The papillæ on the leaves are very minute; some are green and some glittering. The latter, being arranged somewhat in a honeycomb manner, give the leaves a curiously mottled appearance.

The flowers, except in the colour of the petals, are very much like those of *M. viridiflorum*, as figured by Salm Dyck, § 54, fig. 5.

The descriptions of the foregoing species of Mesembrianthemum were all (with the exception of that of *M. intrusum*, living material of which was kindly supplied by Dr. Marloth) made from living plants which flowered in Mr. N. S. Pillan's garden, Rosebank, near Cape Town—without whose generous aid they could not have been done.

HELICHRYSUM EPAPPOSUM, Bolus, n. sp. (Euhelichrysum § Stoechadina).

H. caule sæpissime simplici virgato, foliis lanceolatis acuminatis, capitulis 3-5-fl., sæpius homogamis rarissime heterogamis, in corymbum subumbraculiforme arcte confertis, pappo nullo.

Fruticulus erectus caule sæpe simplici rarius e basi ramoso, ad 55 cm. altus; rami virgati graciles sursum valde attenuati foliosi, araneoso-pubescentes; folia sessilia semi-amplexicaulia, omnia erecta adpressaque, vel inferiora interdum ± erecto-patentia recurvaque, lanceolata, acuta vel acuminata, mucronulata, marginibus recurvis revolutisve, vetustioribus interdum undulatis crenulatis, 1-nervia, superne araneosa demum glabrescentia, inferne lanata, superiora gradatim minora remotioraque, fere adusque basin corymborum attingentia, 0·5–2 cm. (pleraque 1–1·5 cm.) longa, 0·3–0·6 cm. lata; capitula sæpissime homogama, rarissime hetero-

gama (flore unico ♀ in capitulo unico detecto), e cymulis breviter pedunculatis vel sessilibus in corymbum planum araneoso-intertextum, 1·2 cm. diam., arcte congesta, cylindracea, 3–4-fl. rarissime 5-fl., 0·3–0·4 cm. longa; involucri squamæ circa 12, 4-seriatæ, adpressæ, ellipticæ, oblongæ vel late lineares, obtusæ vel subacutæ, flores fere æquantes, exterioribus basi araneosis, fuscescentibus, reliquis glabris nitentibus flavidis apice aureis, 0·15–0·3 cm. longæ; receptaculum alveolatum; corolla 0·18 cm. longa; pappus ⊖; achænia elliptica subcompressa, anguste marginata, glabra, 0·075 cm. longa.

VAR.: β **robustum;** e basi multiramosa, ramis brevioribus, foliis densioribus obtusiusculis.

HAB.: Cape Colony; Griqualand East, near the summit of Malowe Mt., in marshy ground, approx. alt. 1,675 metres, March, *Tyson*, 2756! (in herbb. Kew and Cape Gov.). Natal, swampy ground on Great Noodsberg, approx. alt. 900 metres, April, *J. Medley Wood*, 4131! Nkandhle, *id.* 8827! Transvaal, Mpome Berg, approx. alt. 2,000 metres, March, *R. Schlechter*, 4735! (in herbb. Kew, my own, &c.). Var. β Cape Colony; distr. Maclear, Drakensbergen, near Luhana Pass, approx. alt. 2,280 metres, May, *Galpin*, 2325! Tsitsa footpath, 1,825 metres, March, *Galpin*, 6681! Sutton's Peak, Gatberg, *Baur*, 236!

In habit and general appearance this resembles *H. simillimum*, D.C. But, owing to its alveolate receptacle, without fimbrils or projecting teeth, it should rather be placed in the sub-genus Euhelichrysum, next to *H. umbraculigerum*, Less., to which by its inflorescence it is very similar. It differs, however, by the almost complete absence of female florets, and by the absence of pappus. Whether this last character be constant is at present uncertain. Ten heads from two different gatherings have been examined and no pappus found. This is not a solitary exception in the genus, for no pappus has been found in *H. infaustum*, Wood and Evans, of which, besides the type, I have had the opportunity of examining other specimens. In *H. anomalum*, Less., the setæ are reduced to 1–4 in number.

H. DYKEI, Bolus, n. sp. (Lepicline § Edmondia).

H. foliis oblongis oblanceolatisve, tomentosis; capitulis solitariis magnis turbinatis pedunculatis multifloris; pedunculis dense multibracteatis, bracteis gradatim in squamos involucri transeuntibus; involucri squamis 5–7-*seriatis, exterioribus flores multo superantibus.*

Fruticulus humilis?; rami ad 10 cm. longi rigidi, dense foliosi tomentosi; folia patentia vel erecto-patentia sessilia oblonga oblanceolatave subacuta tomentosa, 0·8–1·4 cm. longa, 0·2–0·4 cm. lata; capitula pedunculata solitaria turbinata 2–2·5 cm. longa, apice 3–4 cm. lata; pedunculi dense bracteati, bracteis imbricantibus ovatis acuminatis membrana-

ceis, gradatim in squamos involucri transeuntibus; involucri squamæ 5–7-seriatæ laxe erecto-patentes, flores multo superantes, exterioribus ovatis, interioribus lanceolatis ad 2 cm. longis, intimis paucis minoribus; receptaculum fimbrilliferum, fimbrillis ovariis brevioribus; flores homogami numerosissimi, corollis 0·7 cm. longis; pappi setæ barbellatæ, 0·6 cm. longæ; achænia oblonga compressa glandulifera, 0·2 cm. longa.

HAB.: Cape Colony, Worcester Div., rocky places on the Matroosberg, alt. c^{a} 2,000 metres, fl. April, *E. Dyke* (No. 4554 in Dr. Marloth's herb.).

The outer involucral scales are rosy at base and white above, the inner entirely white. In floral structure this much resembles *H. humile*, Andr., but is widely different in habit and its short woolly leaves. It may be placed next before that species.

ERICA PYRANTHA, Bolus, n. sp. (§ Evanthe, Salisb. emend.).

E. foliis 4-*nis*, *floribus* 1–3-*nis terminalibus subsessilibus, sæpius in ramulis brevissimis et idcirco specie axillaribus, bracteis remotis, sepalis ovatis scariosis, corollis tubularibus* 0·5 *cm. longis, staminibus inclusis antheris aristulatis, ovario piloso.*

Rami adscendentes cum ramulis foliosis virgatis gracilibus puberuli demum glabrescentes; folia 4-na erecto-patentia gracilia linearia subacuta, dorso leviter canaliculata, pleraque in ramulis abbreviatis floriferis congesta, 0·4–0·5 cm. longa; flores terminales sæpius solitarii, rarius 2–3-ni, sæpe subsecundi, patentes demum deflexi, pseudo-racemum efformantes; pedicelli 0·2–0·25 cm. longi; bracteæ remotæ minimæ, 1 basilaris, 2 infra medium, glabræ, coloratæ, vix 0·1 cm. longæ; sepala erecto-appressa, late ovata acuta scariosa in apiculum foliaceum desinentia, glabra, 0·2 cm. longa; corolla tubulosa, sursum paullo ampliata, fere recta, glabra, semi-transparens aurantiaca, basi rubescens, limbi segmentis erectis rotundatis, 0·2 cm. longis, tota 1 cm. longa, c^{a} 0·3 cm. lata; filamenta capillaria, 0·5 cm. longa; antheræ inclusæ, oblongæ, apice attenuatæ læves, 0·1 cm. longæ; poro $\frac{3}{8}$ cellulæ, supra basin affixæ, brevissime aristulatæ, aristis vix ultra basin cellularum productis; stylus inclusus vel rarius manifestus vel brevissime exsertus, ruber, 0·8–1 cm. longus; stigma capitellatum; ovarium 4-loculare, obconicum, sericeo-pilosum. (*Ex exempll. vivis.*)

HAB.: Cape Colony, South-western Region, reported to come from the Caledon Div., and sold fresh in the streets of Cape Town, fl. Aug. (1908), Bolus herb. 13023.

A very distinct and pretty species, unlike any known to me. The flowers grow in apparently secund racemes towards the upper part of the branches. But they are strictly terminal and arise from short arrested lateral branchlets. The few barren branchlets on our specimens, of from 1–2 cm. in length, bear leaves which are uniformly crowded throughout

and do not form congested tufts. Almost all the species of the § Evanthe have long-tubed flowers, excepting only a very few which are clearly short-tubed forms of species with long tubes. According to the Key to the Cape species of the genus in Flora Capensis, v. 4, p. 15, it should stand next to *E. glandulosa*, Thunb., but is quite unlike that species in appearance and structure. I am indebted for specimens to Miss A. M. Krige, who obtained it from one of the numerous flower-sellers in Cape Town.

Erica Pillansii, Bolus, n. sp. (§ Evanthe, Salisb.).

E. affinis E. Mertensianæ, Wendl., differt pedicellis brevioribus, floribus plerisque solitariis, corollis brevioribus pubescentibus, antheris inclusis, ovario hirsuto.

Rami adscendentes pubescentes, ramulis brevissimis floriferis plerique induti; folia 4-na imbricata erecta linearia vel subfiliformia acuta, dorso vix vel raro sulcata, minute puberula, 0·5–0·7 cm. longa, 0·05 cm. lata; flores terminales solitarii vel rarius 2–3-ni; pedicelli 0·25 cm. longi; bracteæ 2 mediæ, 1 remota, minutæ lanceolatæ scariosæ; sepala ovata lanceolatave acuta mucronata scariosa puberula ciliolata, 0·3 cm. longa; corolla subbucciniformis leviter incurva, extus puberula coccinea, 1–1·4 cm. longa, limbi segmentis oblongis obtusis concoloribus, 0·25 cm. longis; stamina inclusa, faucem attingentia vix perspicua; filamenta capillaria; antheræ oblongæ rectæ, supra basin ad filamentum affixæ, 0·08 cm. longæ, poro $\frac{2}{5}$ longitudinis cellulæ, aristis subulatis acuminatis pendulis, 0·035 cm. longis; stylus breviter exsertus; stigma capitatum; ovarium hirsutum, pilis longis crassis albis.

Hab.: Cape Colony, Caledon Div., fl. May–Jan., *Pillans*, 585!

Nearly allied to *E. Mertensiana*, Wendl., but differing as noted above. That species is only known to me from Klotzsch's ample description and was founded on specimens from an English garden. The present species resembles at first sight *E. cruenta*, Soland., but differs by its mostly longer and slenderer leaves, by its shorter pedicels, shorter corolla, and hirsute ovary. It appears to be abundant, having lately been sold in the streets of Cape Town.

Erica serratifolia, *Andr. Col. Heaths*, t. 58; Heathery, t. 44.

Var.: **subnuda,** Bolus, n. var.; characteribus typi sed foliis calycibusque margine nudo vel junioribus interdum ciliatis, bracteis scariosis minoribus.

Hab.: Cape Colony, Caledon Div., mountains between Caledon and Hermanus, fl. May, Sept., *N. S. Pillans*, 228! 1334!

E. serratifolia is only known, and was described, from garden specimens; the peculiar plumose hairs mentioned by Wendland and figured by him in his *Eric. Ic. fasc.*, 12, t. 5, may possibly have been the result of

cultivation. Neither Salisbury nor Loddiges, who supposed they had the same species, make any mention of this character.

Erica tenuibractea, Bolus, n. sp. (§ Ceramus, Salisb.).

E. affinis E. inflatæ, Thunb., sed bracteis approximatis, sepalis foliaceis longioribus, antheris diversiformibus, appendicibus multo brevioribus, ovariis subsessilibus, differt.

Rami erecti puberuli, ramulis florigeris erecto-patentibus; folia 4-na dense imbricata erecto-patentia linearia subacuta, minute glanduloso-ciliolata glabra, 0·6–0·7 cm. longa; umbellæ 7–14-fl.; pedicelli erecto-patentes graciles glanduloso-viscidi, rubro-brunnei 2·6 cm. longi; bracteæ arcte approximatæ lineares foliaceæ, 0·6 cm. longæ; sepala erecta subulato-linearia acuta foliacea glanduloso-ciliolata, 0·6 cm. longa; corolla elongato-ovata puberula viscidula dilute rosea, limbi segmentis in specimine exsiccato erectis conniventibus rubris 0·15 cm. longis, tota 1·2 cm. longa, parte latissima (exsiccatione compressa) 0·6 cm. lata; filamenta capillacea 1 cm. longa; antheræ inclusæ, in longitudinem semi-ovatæ, paullo supra basin dorsifixæ, brevissime aristatæ, 0·15 cm. longæ, poro longitudine $\frac{1}{3}$ cellulæ; stylus breviter exsertus; stigma capitellatum; ovarium obovatum subsessile minute puberulum (5-loculare—ex flore unico dissecto).

Hab.: Cape Colony; Klein Drakensberg Mts., Paarl Div., Collector unknown (exhibited at the Paarl Wild Flower Show, Jan. 23, 1908). Communicated by Mr. N. S. Pillans, No. 1311 (in his herb. and mine).

A very distinct species which should be placed next after *E. inflata*, Thunb., in the sequence of the "Flora Capensis," vol. iv., section 1, p. 99. Besides the differences from that species noted above, the corolla of the present is about one-half larger and is minutely puberulous. The species has also a considerable resemblance to *E. obliqua*, Thunb., § Pachysa (which would probably have been better placed in the § Ceramus), but differs considerably in its calyx and bracts. The specimens seen, though scanty in quantity, are in excellent state.

Erica Rudolfii, Bolus, n. sp. (§ Ephebus, Salisb.).

E. affinis E. modestæ, Salisb., differt bracteis sepalisque linearibus, antheris linearibus, ovario puberulo, aliisque notis.

Rami validi rigidi pubescentes, ramulis brevibus superne vestiti; folia 3-na, juniora dense imbricato-conferta incurva, inferiora sublaxiora, lineari-semiteretia obtusa sulcata puberula ciliolata demum glabrescentia, 0·2–0·25 cm. longa; flores terminales 3-ni; pedicelli 0·2 cm. longi; bracteæ lineares foliaceæ, 2 approximatæ 1 paullo inferior; sepala linearia foliacea obtusa ciliolata pubescentia, 0·3 cm. longa; corolla ovato-suburceolata, vix vel raro fauce constricta, puberula, 0·5 cm. longa alba, limbi segmentis erectis recurvisve ovatis carneis, tertia parte tubi longis;

antheræ inclusæ vel subexsertæ basi dorsifixæ lineares obtusæ, 0·1 cm. longæ, poro 0·062 cm. longo, aristatæ, aristis pendulis circa 0·08 cm. longis; stylus breviter exsertus validus ruber; stigma capitatum 4-punctulatum nigrum; ovarium subglobosum puberulum, in disco pubescente nigro situm.

HAB.: Cape Colony, on the Langebergen, near the town of Montagu, alt. 1,200 metres, fl. Oct., *R. Marloth*, 3250!

Described from specimens which may not, perhaps, be completely developed; the limb of the corolla may therefore become more spreading and the anthers more exserted. In any case the species is certainly distinct. Its affinities are with *E. modesta*, Salisb., and it should be placed between that and *E. oresigena mihi.*

ERICA EBRACTEATA, Bolus (§ Arsace, Salisb.).

E. bracteis nullis, sepalis ovatis minutis, corollis crateriformibus albis, antheris muticis, stylo exserto, stigmate cyathiformi-peltato, ovariis glabris.

Fruticulus ramosus 1–1·6 metralis. Rami adscendentes pubescentes, ramulis gracilibus, ultimis tantum florigeris, floccosis pilis minutis pinnatis; folia 3-na suberecta, dense imbricata linearia, parce puberula, 0·3 cm. longa; flores terminales 3-ni; pedicelli incurvi puberuli, 0·1 cm. longi; bracteæ desunt; sepala ovata acuta subcrassa, 0·08–0·1 cm. longa; corolla crateriformis vel rarius subcampanulata glabra, 0·17–0·18 cm. longa, limbi segmentis erectis vel rarius leviter recurvis, late rotundatis, tubo æquilongis vel paullo brevioribus; filamenta infra antheram sigmoideo-inflexa; antheræ manifestæ vel subinclusæ laterales ovatæ glabræ, 0·083 cm. longæ, muticæ brunneæ, poro longitudine $\frac{2}{5}$ cellulæ; stylus breviter exsertus validus rectus; stigma cyathiformi-peltatum; ovarium subglobosum glabrum.

HAB.: South Africa; by streams near the Mont-aux-Sources, in the valley of the Injassuti River, alt. 1,500–1,800 metres, Oct. 29, 1890, *J. Thode*, 59.

A well-marked species most nearly allied to *E. salax*, Salisb., next before which it may be placed. The corolla is of almost exactly the same shape but larger, while the limb-segments are proportionately shorter; the leaves also are different. The most important difference is the remarkable and apparently constant absence of bracts, a very rare character in the genus. In this respect, as well as by its muticous anthers, it differs also from the somewhat similar *E. leucopelta*, Tausch.

ERICA ZWARTBERGENSIS, Bolus, n. sp. (§ Arsace, Salisb.).

E. affinis E. copiosæ Wendl., differt indumento, floribus paucioribus, corollæ textura crassiore coloreque, antheris calcaratis calcaribus longe ciliatis, ovario glabro.

Fruticulus ramosus, 30–40 cm., altus vel ultra; rami cum ramulis adscendentes foliosi puberuli, apice florigeri; folia inferiora erecto-patentia, superiora erecta dense imbricata 3-na subulata subobtusa, dorso sulcata glabra levia nitida crassa, 0·3–0·4 cm. longa; flores terminales 3-ni; pedicelli viscidulo-puberuli, 0·2 cm. longi; bracteæ 3, arcte approximatæ lineari-lanceolatæ scariosæ viscidæ, 0·18 cm. longæ; sepala bracteis conformia sed paullo longiora latioraque; corolla campanulato-cyathiformis viscidula textura crassiuscula, limbi segmentis rotundatis, ca. 0·08 cm. longis, tota 0·25 cm. longa; antheræ manifestæ corollam fere æquantes, basi dorsaliter affixæ ovatæ obtusæ, basi obliquæ calcaratæ, calcaribus pendulis longe ciliatis longitudine dimidio antheræ, poro ⅓ cellulæ, cellulæ 0·1 cm. longæ; stylus exsertus; stigma capitatum; ovarium depresso-globosum glabrum pallidum.

Hab.: Cape Colony; Prince Albert Div., in rocky places above the Zwartberg Pass, alt. 1,675 metres, fl. Dec., *Bolus*, 11600! (in herb. Kew).

In external appearance most resembling *E. hispidula*, L.; but in floral structure most nearly allied to *E. copiosa*, Wendl., differing in its indumentum, its fewer flowers, in its corolla of a thicker and less petaloid texture of a dull horn-like colour, in its anthers being always calcarate and the spurs always long ciliate, finally in its glabrous ovary. It should be placed next after the last named.

Erica Lowryensis, Bolus, n. sp. (§ Eurystoma, Benth.).

E. affinis E. comatæ Guthrie et Bolus; differt foliis bracteis sepalisque glabris, sepalis lanceolatis subplanis nec concavis, corollæ segmentis angustioribus, filamentis apice ampliatis in connectivum transeuntibus.

Fruticulus erectus, 30 cm. altus vel ultra; caules adscendentes validi, in parte superiore pilis longis dense hispidi, in parte inferiore glabrescentes; folia terna imbricata erecto-subincurva linearia, supra plana, subtus sulcata vel interdum marginibus revolutis subaperta, pleraque glabra, raro paucissima juniora tantum ad apices ramulorum pubescentia cite glabrescentia, 0·4–0·5 cm. longa; flores terminales, 3-ni, subcorollini, numerosi; pedicelli pubescentes, 0·25 cm. longi; bracteæ minimæ subapproximatæ lanceolatæ, 0·11 cm. longæ; sepala ovato-lanceolata erecto-appressa acuta vel acuminata 1-nervia, fere plana subcoriacea glabra subciliolata pallida, 0·2 cm. longa; corolla obconica glabra candida, 0·4 cm. longa, limbi segmenta semi-ovata subobtusa, 0·15 cm. longa; stamina manifesta, corolla paullo breviora; filamenta capillaria, apice in connectivum ampliata; antheræ laterales dorso ad basin affixæ oblongæ muticæ nigræ, 0·1 cm. longæ; poro cellula duplo breviore; stylus breviter exsertus; stigma capitellatum; ovarium tomentosum.

Hab.: Cape Colony; mountains, Sir Lowry's Pass, Stellenbosch Div., fl. Sept., *N. S. Pillans*, 586 (in herb. Pillans, Kew, my own, &c.).

Allied to *E. comata*, Guthrie and Bolus, next to which it should be placed, differing by (1) its long shaggy hairs on the main branches; (2) its leaves mostly quite glabrous, more deeply sulcate and sometimes open-backed (*i.e.*, with revolute margins and the under surface of the leaf visible between); (3) the leaves, bracts, and sepals destitute of the apical tufts of hairs peculiar to *E. comata;* (4) sepals more acute, of very different appearance, thicker texture, and nearly flat; (5) by its more densely tomentose ovary.

ERICA WYLIEI, Bolus, n. sp. (§ Eurystoma, Benth.).

E. affinis E. flocciferæ, Zahlbr., differt foliis majoribus, bracteis laxioribus, sepalis lanceolato-ovatis acuminatis, corolla parum minoribus, antheris semi-ovatis angustioribus appendicibus brevioribus, ovario tomentoso.

Rami e caudice rhizomatico erecti virgati graciles floccoso-pubescentes, 25–28 cm. alti, ramulis brevibus adscendentibus parce florigeris; folia et 3-na et 4-na erecta imbricata semiteretia, dorso rotundata sulcata glabra ciliolata, 0·4–0·6 cm. longa; flores 3-ni; terminales, pedicelli, 0·3 cm. longi; bracteæ 2 superiores subapproximatæ, 1 inferior fere basilaris omnino foliacea; sepala lanceolato-ovata acuminata ciliolata apice carinata, 0·3 cm. longa; corolla obconica vel subcampanulata carnea extus minute puberula, 0·4 cm. longa, cum limbi segmentis obtusis, 0·15 cm. longis; filamenta capillaria; antheræ dorso affixæ, in longitudinem semi-ovatæ, 0·075 cm. longæ, poro $\frac{2}{3}$ cellulæ, appendicibus in filamentum decurrentibus apice liberis aristatis brevibus; stylus breviter exsertus; stigma capitato-obconicum; ovarium subglobosum tomentosum.

HAB.: Natal, Giant's Castle Mountain, alt. 2,500–3,000 metres, fl. Oct. 22, 1907, *J. Wylie*, in the Natal herb., 10660!

Allied to *E. floccifera*, Zahlbr. (*E. floccosa*, Bartl. non Salisb.), but differing by the characters enumerated above. It may be placed next after that species.

WATSONIA FLAVIDA, Bolus (nomen novum).

Tritonia watsonioides, Baker, in Handb. *Irid.*, *p.* 195, *Flor. Cap. Dyer*, vi., 127.

Species in specimine ex Barberton, Transvaal a Galpin lecta No. 814, stabilita, totos characteres, præsertim ramos styli bifidos, Watsoniæ exhibet, tum habitu congruit.

Exemplar typicum in meo herbario examinavi.

HAB.: Swazieland, prope 'Mbabane, alt. 1,550 metres, Dec., *Bolus*, 12343. Flores flavido-albidi.

GASTERIA PILLANSII, Kensit, n. sp. (Liliaceæ-Asphodeloideæ-Aloineæ), § vi., Grandifloræ.

G. candicanti, Haw., affinis sed foliis exacte distichis utrinque convexiusculis ecarinatis obtusissimis distinguitur.

Acaulis; folia exacte disticha patenti-incurva linguæformia obtusissima mucronata, marginibus tuberculatis, utrinque convexiuscula et copiose albido-punctata, punctis immersis, sordide viridia, 10–17 cm. longa, 4–4·5 cm. lata, medio 1 cm. crassa; pedunculus terminalis simplex ad 50 cm. longus, racemo ad 40 cm. longo; bracteæ hyalinæ lanceolatæ acuminatæ 0·7–1·3 cm. longæ; pedicelli rubri, 0·7–1·3 cm. longæ; perianthium basi minime inflatum subcurvulum miniatum 3–4·5 cm. longum, 0·4–0·8 cm. diam., segmentis apice rotundatis 0·5–0·6 cm. longis; stamina subæqualia vel inæqualia inclusa; ovarium cylindraceum 0·8 cm. longum, stylo stamina paullo excedente.

HAB.: Cape Colony, Clanwilliam, fl. Nov., *N. S. Pillans*, 833! (in herb. Bolus).

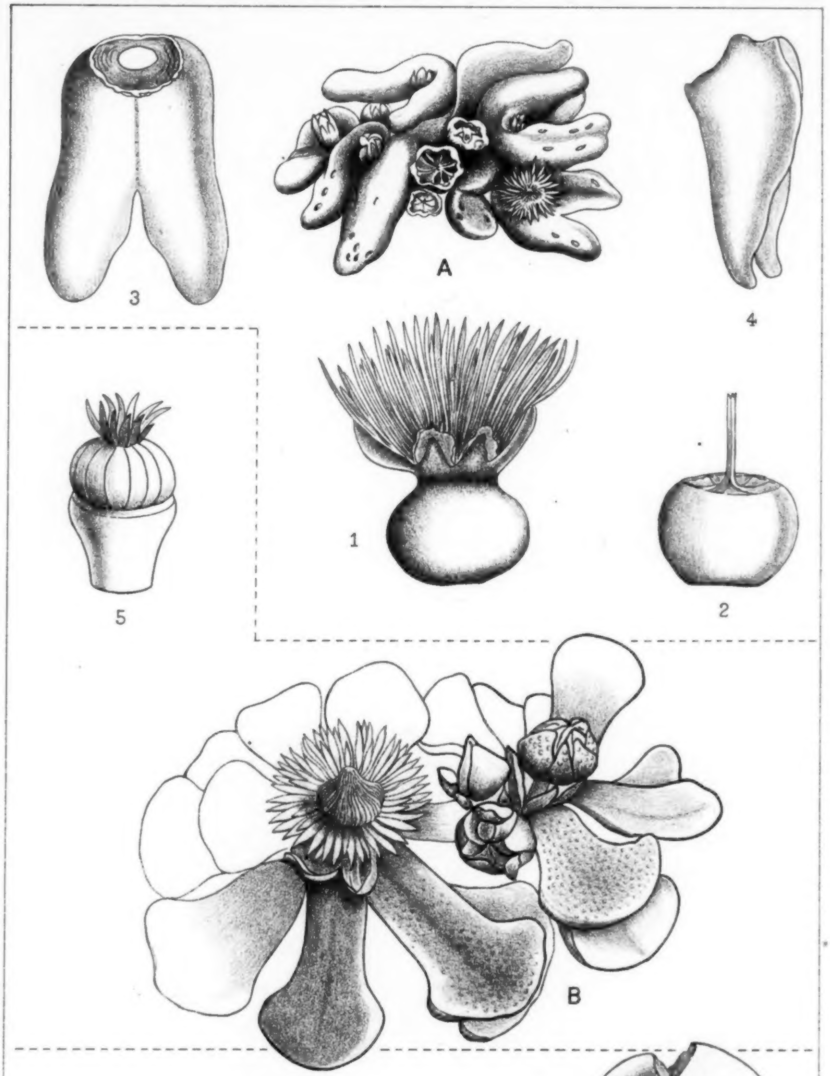
This has almost exactly the habit and leaves of *G. obtusifolia*, Haw., but with quite different flowers. The latter are like those of *G. candicans*, Haw., except that the perianth is more suddenly constricted below the ovary, not gradually attenuated, and it usually has no trace of green markings on it.

Described from living specimens which flowered in Mr. N. S. Pillans' garden, Rosebank, near Cape Town.

PROTEA CRYOPHILA, Bolus. *P. chionantha, Bolus, in Trans. S. Afr. Philos. Soc., v.* 16 (1906), *p.* 399, *not of Engler* and Gilg. *in Warb. Kunene-Sambesi-Exped.* (1903), *p.* 225.

SENECIO TRANSVAALENSIS, Bolus. *S. thermarum, Bolus, in Trans. S. Afr. Philos. Soc., v.* 16 (1906), *p.* 389, *not of Philippi in Linnæa, v.* 33 (1864–5), *p.* 153.

HELICHRYSUM LAMPROCEPHALUM, Bolus. *H. calocephalum, Schlechter, in Engl. Bot. Jahrb., v.* 40 (1905), *p.* 95, *not of Klatt in Bull. Herb., Boiss., v.* 4 (1896), *p.* 834.



H. Bolus del. West, Newman lith.

A. MESEMBRIANTHEMUM RETROVERSUM *Kensit.*
B. " ROSULATUM "
C. " CRYPTOPODIUM "

DESCRIPTIVE CATALOGUE OF THE COLEOPTERA OF SOUTH AFRICA.

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Director South African Museum.

Plates XXII.-XXIV.

Family MELOIDÆ.

Mentum supported by a pedunculate gular process; ligula always projecting, more or less deeply sinuate, or sometimes incised; maxillæ with two corneous ciliate or penicillate lobes greatly variable in shape; palps seldom very long, the labial three-jointed, but with a distinct palpiger, the maxillary four-jointed; head much inclined, sometimes bent under, ending in a distinct neck not entirely received in the prothorax, the frontal part, as far as the antennæ which are inserted close to the eyes, is quadrate or transverse with the epistome and the labrum narrowed but parallel or nearly so laterally, or the whole head is triangular and even cuneiform; the suture of the epistome is at times wanting, eyes variable in size, strongly granulated, sub-reniform or hardly emarginate in front, but occasionally greatly developed underneath, and even sub-contiguous there (*Zonitoschema*). Number of antennal joints eleven, but occasionally reduced to seven in the *Mylabrini*, and inserted in front of the eyes in all the South African species; prothorax narrower than the elytra; prosternum without lateral suture, coxæ very large, the anterior contiguous with the cotyloid cavities very widely open behind, confluent, the intermediate contiguous behind, the posterior transverse; mesosternum short, triangular; metasternum very short in the *Meloinæ*, long in the *Cantharinæ;* elytra without epipleuræ; abdomen six-jointed; legs long, tibial spurs always distinct, those of the hind tibiæ variable in shape, the outer one often thickened and hollowed outwardly; anterior and middle tarsi five-jointed, posterior four-jointed; claws usually divided into two parts, the lower much more slender than the upper, and occasionally filiform, the upper pectinate or simple.

This Family belongs to the group of Heteromera characterised by the presence of five joints in the anterior and middle tarsi, and four in the hind tarsi. The head ends in a distinct neck as in the Families *Anthicidæ*,

Pyrochroidæ, *Rhipiphoridæ*, &c., which also belong to the **Heteromera**, but the *Meloidæ* are easily recognised by their bi-partite claws. In some species of *Cantharis*, however, the lower part is partly or nearly completely fused with the upper.

A glance at Plate XXII., in which a figure of all the South African genera is given, shows how very different the facies of the *Meloidæ* is, and how very dissimilar also are the buccal organs of, let us say, *Synhoria* and *Nemognatha*, of *Meloë* and *Zonitodema*.

All the members of this Family have soft integuments, and they probably all emit through the leg-joints a substance called *cantharidine*, the chemical formula of which is $C_5H_6O_2$, and which is used in medicine for raising blisters on the human skin, and other purposes.

The amount of cantharidine obtained from the South African Mylabridæ is said to exceed that of *Cantharis vesicatoria*, the species from which in Europe this produce is obtained.

According to Beauregard, two of the three or sometimes four pairs of glands connected with the genital organ of the male, and serving also as a seminal reservoir, are the seat of production of the active principle of the cantharidine. It is also found in the copulating sac, and in the ovaries of the female, but it is not restricted to these organs only, as it exists in the blood. The eggs have also an energetic blistering power, and we may conclude therefore that the larvæ even in their first stage have the same power as the eggs. This property, however, is stated to be less powerful in the *Zonitini* than in the *Meloini* and *Cantharini;* and is said to be absent in the *Horiini*. But the South African species *Synhoria hottentota* emits, like the species of *Meloë*, a pale yellow liquid through its leg-joints. As this liquid, which was erroneously thought to be blood, is found in the case of *Meloë* and other *Cantharini* to contain cantharidine, it is not unreasonable to suppose that it contains some also in the case of *Synhoria*.

In the adult stage most *Meloidæ* feed on foliage, grass or flowers. *Mylabrini* are, in South Africa, very destructive to the flowers of Leguminosæ. *Mylabris oculata* proves very injurious to crops of beans, peas, &c., in the Eastern part of the Cape Colony, and also in the Transvaal. Of late it has taken to the blossoms of cultivated fruit trees. It is also at times not uncommon on the blossoms of our thorn, *Acacia horrida*. *Mylabris hottentota* is equally abundant in Natal and the Transvaal, to say nothing of the Orange River Colony, and any cultivated flower, roses especially, seems to be especially attractive to this species. I have never noticed any South African *Mylabris* feeding on leaves. *Synhoria hottentota* is met within or in the immediate vicinity of the dried logs or standing posts in which the carpenter bees of the genus *Xylocopa* have burrowed their nests. *Meloë*, like its congeners elsewhere, drags its tumid body on the ground, and feeds on the foliage of low plants. *Cyaneolytta*

crawls about the ground, or is to be seen on the young grass, which it devours with great voracity. Rev. J. O'Neil, of Plumtree, Southern Rhodesia, informs me that a species (*C. signifrons*) "was particularly abundant a week after the first summer rains. He saw 3 or 400 under a single bush." Of the three species of *Cantharis* with glabrous elytra, one, *C. nitidula*, is usually found on the iridaceous plant *Bobartia spathæa;* another one, *C. lucida*, in nearly any flower; *Iselma* again is met with in numbers in the flowers of the *Gazania* and *Dimorphotheca*, belonging to the Compositæ. When fearing attack or capture all sham death, drawing their head against the prosternum, tucking the legs under the body, and emitting at the same time through the leg-joints the pale yellow fluid already mentioned. It has been proved that this fluid is a means of protection against lizards, and probably also against small mammals or birds. The very conspicuous livery of the *Mylabrini* acts probably as a "danger signal" for their would-be devourers. Be it as it may, they supplement it by a very fetid, almost nauseous smell when seized.

In the adult stage, most of the species the life history of which is known fully or partly, make a hole in the ground in which they lay the eggs. *Meloë*, however, do not deposit them in one spot only, or at one given time. They are extremely prolific insects, but the number of eggs varies, however, according to the size. Newport found 4,218 eggs in the ovaries of a female. Goedart counted 3,000 in the first laying, and 900 in the second. *Cantharis* deposit their eggs in two masses containing from 150 to several hundreds. *Mylabris* are not so prolific, the number of the eggs varying from 25 to 40. *Sitaris* do not lay the eggs in a hole, but deposit them at the entrance of the burrows or galleries of solitary bees. Fabre evaluates the number of eggs laid in that position by one female at 2,600 eggs. There is reason, however, to believe that usually the number is less than that, although still very considerable. In their early stages the *Meloidæ* are parasites. They either feed on the honey made by Hymenoptera, on the orthopterous insects collected as food-stores by fossorial wasps: on the eggs of locusts, the egg-pod of which they enter, or here on the larvæ of ground-loving Psychid moths, into the sac of which they have penetrated. The eggs are laid in all likelihood near the nests of the bees or wasps, or the place of oviposition of the locusts.

But instead of passing through the three usual stages, or instars, of larva, pupa, imago, they undergo from six to eight transformations, changing altogether their first form, losing their legs, turning to bladder-like creatures which at a later stage become again active, returning in the fourth stage to the shape of the second, &c. These unusual changes are called Hypermetamorphoses.

The young larva is called Triungulin. It is always a tiny, very active

creature with a broad head and strong mandibles, the three pairs of long legs terminating each in three tarsal claws.

In the case of *Meloë* and certain kinds of *Cantharis* feeding on honey and possibly bee-bread, the Triungulin or primary larva climbs the stem of plants and awaits there the arrival of bees or other flower-frequenting insects, hooks itself on their hairs, and, if its carrier happens to be a bee, it is conveyed into the nest. It penetrates a cell during the oviposition, or possibly after the storage of the cell is already completed, and devours first the egg of the rightful owner and turns into the second larva which assumes quite a different aspect, having on that account the name caraboid-stage given it; it is soft, and eventually assumes the third stage, that of pseudo-pupa, but still within the second larval skin; it is then mostly motionless; in the next stage this pseudo-pupa turns to a larval form closely resembling that of the second instar, but also without shedding its skin, being thus wrapped into two; in this envelope it changes to the true pupa, and lastly appears as the perfect insect. It has then undergone six transformations.

According to Riley, these post-embryonic developments are a little more complicated in the cases of some North American species of *Cantharis* (*Epicauta*), the young of which feed on locust eggs. The active triungulin does not cling to the hairs of bees, but sets about finding the egg-pods of locusts. Should two or more triungulins penetrate the same egg-pod, they fight until only one is left. The instars are then as follows (ap. Sharp): (1) Triungulin larva-moult; (2) Caraboid larva-moult; (3) Scarabæoid larva-moult; (4) Scarabæoid larva ultimate stage-moult; (5) Coarctate larva-moult; (6) Scolytoid larva-moult; (7) pupa-moult; (8) perfect insect. It may, however, be added that Riley's three and four instars do not differ much from the sixth.

Sitaris deposit their eggs at the mouth of the galleries of burrowing Hymenoptera. In one species observed by Fabre the triungulins pass the winter there, motionless, under the shell of the egg, before clinging to the hairs of the passing *Anthophora* that are to introduce them into the galleries of the nest. But in other species the triungulin fastens itself at once to the *Colletes*, *Halictus*, or *Andrena* bees entering the nests.

The different stages in this hypermetamorphosis vary in duration; the habits of the larvæ of different species and genera are also presumably not the same.* Certain species are certainly produced during a season, others are not. It seems from all observations that it is in the pseudo-pupal state that the stage is the longest, lasting occasionally over a year. In *Cantharis vesicatoria* Beauregard finds that the triungulin, unlike in that respect that of *Meloë* and *Sitaris*, does not devour the hymenopterous egg laid in the cell, but feeds on the honey at once, and that the second larva

* See p. 290.

instead of remaining enclosed in the cell, the contents of which it has emptied, buries itself into the ground to a depth of 3 feet, and, after a third moulting, changes there into a pseudo-pupa. This third moulting corresponds thus to Riley's first Scarabæoid stage of the congeneric *Cantharis* (*Epicauta*) of North America, which, however, in the second stage forms only a small cavity near the egg-pod from which it has derived its nourishment. The young of *Cerocoma*, a genus not represented in Africa, attack the stores of provision brought together by a burrowing wasp of the genus *Tachytes*, and consisting of paralysed young Mantis intended by the wasp for its young.

Nothing is known of the habits of the *Mylabrini* beyond the fact that the triungulins are considerably larger than those of *Meloë* and *Cantharis*, and that the number of eggs is very much smaller.

It must not, however, be imagined that those triungulins which ascend plants to encounter the carrier that will introduce them into its abode show any discrimination as to the identity of their conveyance, because they do not, and I have seen some holding on to the rare hairs of dipterous flies, and also on flower-frequenting Coleoptera. Their chance of finding a "home" is thus made greatly uncertain, and the number of successful ones is probably very small. But the great fertility of some of the species counterbalances this great disadvantage.

In South Africa examples of *Meloë*, the most prolific of the *Meloidæ*, are undoubtedly rare. On the other hand, *Cantharini*, *Mylabrini*, *Zonitini* are very numerous in kinds and extremely abundant in individuals.

One genus, *Iselma*, is purely endemic; *Zonitomorpha* may prove also to be so.

The Family is divided into two Sub-Families, distinguished as follows:—

Metasternum very short, intermediate coxæ covering part of the posterior ones; side pieces of meso- and metathorax covered by the epipleuræ of the elytra; no scutellum, or scutellum extremely reduced; no wings ..	MELOINÆ.
Metasternum long, intermediate coxæ distant from the posterior; side pieces of meso- and metathorax plainly visible; scutellum well defined; body nearly always winged	CANTHARINÆ.

SUB-FAMILY MELOÏNÆ.

This Sub-Family is represented in Africa by the genus *Meloë* only, which numbers in South Africa five species, of a dark blue or blue-black colour, making their appearance in the spring or after the first summer rains, and met with in dry or sandy spots where the nests of Hymenoptera abound. They do not proceed fast, the females especially, owing to the extreme development of the abdomen the segments of which are enor-

mously distended. The sexual differences consist in the males being usually smaller than the females, and in the apical abdominal segment of the former being more or less deeply incised, while it is entire in the latter; but in certain species the intermediate antennal joints are nodose or greatly enlarged in the male.

Gen. MELOË, Linn.,

Syst. Nat., 10th ed., 1758, p. 419.

Mentum (pl. xxii., fig. 3) transverse, sub-angular laterally and sinuate near the margin; ligula also transverse, arcuate, ciliate along the anterior margin, labial palps robust, thick, the ultimate triangularly dilated, almost truncate at apex; maxillæ (pl. xxii., fig. 3*a*) also robust, both the inner and upper lobes dilated and densely ciliate, pubescent at apex; maxillary palps moderately long and of the same shape as the labial; labrum transverse, either emarginate at apex or not; mandibles robust, more or less hidden by the labrum; head longer than broad, with the transverse epistome greatly narrowed, eyes only moderately large; antennæ variable in shape and length, the second basal joint always much smaller than the third, the last one longer than any of the preceding ones, sub-arcuate outwardly, straight inwardly and sharp at tip; prothorax of variable shape (pl. xxii., figs. 3, 4); scutellum atrophied; elytra very short, strongly divaricating from or near the scutellary region, much shorter than the abdomen; wings absent; legs moderately long or long, tarsi as long as the tibiæ or longer; outer spur of hind tibiæ thick, obliquely truncate outwardly, or sub-lanceolate and excavated, inner spur slender and sharp; upper part of claw not pectinate, lower very slender.

The abortion of the wings, the great divarication of the elytra, and the extremely large abdomen impart to the insects belonging to this genus a facies of their own. When seized they exude through the joints of the legs, especially the knees, a yellow fluid, much in the same manner as in the genus *Horia*. It is this peculiarity which has gained for them the popular name of "oil beetles."

Four species are recorded from Central Africa, but none from Senegambia, where, however, the genus is probably represented.

Key to the Species.

A^2. Antennæ barely reaching the posterior angle of the prothorax.

B^2. Prothorax with a median longitudinal groove and no transverse impression along the base.

a^2. Body black.

Prothorax very roughly scrobiculate, as broad as long and sharply angular laterally in front; elytra finely plicate-wavy longitudinally .. .. *angulatus.*

a^{1}. Body dark blue.

Prothorax foveate punctate, longer than broad, angular laterally in the male, moderately so in the female; elytra with longitudinal highly raised wavy lines; upper side of abdomen longitudinally striolate .. .. *meridianus.*

Prothorax scrobiculate, longer than broad, well rounded laterally in front; elytra with very highly raised and very wavy longitudinal folds; abdomen with strong, rugose wavy folds .. .. *caffer.*

A^{1}. Antennæ reaching beyond the humeral part of the elytra.

B^{1}. Prothorax not grooved longitudinally, and with a transverse impression along the base.

Sixth and seventh antennal joint very broadly dilated, and hollowed underneath in the male.

Anterior part of prothorax not angular laterally in front.

Body dark blue or blue-black; elytra with very closely set, little raised, wavy folds.

Prothorax plainly ampliate, rounded laterally in front, and covered with deep, closely set, round punctures; intervals somewhat roughened .. .. *hottentotus.*

Prothorax only slightly ampliate, rounded in front, and with round, not closely set punctures, intervals quite smooth .. .. *rhodesianus.*

Meloë angulatus, Leach,

Plate XXII., figs. 3, 3*a*, 3*b*.

Trans. Lin. Soc., xi., 1815, p. 247; Brandt and Erikss., Mon., p. 132, pl. 8, fig. 5.

Black, somewhat opaque; head scrobiculate foveolate, the foveæ divided by a sharp, raised wall, the hind part is slightly wider than the anterior part of the prothorax and slightly canaliculate on the vertex only, the groove disappearing as it reaches the middle of the frontal part; antennæ black, short, not reaching beyond half the length of the prothorax; prothorax somewhat short, as broad as long at its widest part, straight laterally, sub-truncate in front with the lateral angles very sharp, and the posterior slightly blunted, covered with broad scrobiculate foveæ with more uneven walls than those on the head, deeply and somewhat broadly grooved longitudinally in the centre, and with a supra-marginal longitudinal depression on each side; elytra divaricating at about one-third of the length and covered with closely set, little raised, slightly wavy folds; abdominal segments longitudinally shagreened; legs pubescent, claws piceous.

Length (excl. of abdomen) 12–16 mm.; width 7–12 mm.

Hab. Cape Colony (Cape Town, Malmesbury, Stellenbosch, Paarl, Worcester, Namaqualand, Knysna).

MELOË MERIDIANUS, Pér.,
Trans. S. Afric. Phil. Soc., iv., 1892, p. 12.

Very dark blue, moderately shiny; head broader than the anterior part of the prothorax and covered with round, deep, sub-foveolate punctures the intervals of which are somewhat broad and smooth, the posterior part of the vertex is only slightly sinuate in the centre but not canaliculate; prothorax straight laterally but narrower at the base than in the anterior part, the hind angles are distinct although not acuminate, the anterior ones are also plain, although slightly blunt, but from there the anterior part is strongly narrowed obliquely, the median part is very broadly grooved from apex to base, there are no traces of a supra-marginal lateral longitudinal depression, and the surface is covered with deep, foveate punctures separated by a narrow, somewhat raised smooth wall; elytra divaricating at about one half of the length and covered with highly raised, very wavy longitudinal folds separated from each other by an interval wider than the fold itself; abdomen longitudinally shagreened; legs densely but briefly pubescent.

Length 10–14 mm.; width 6–7½ mm.

Hab. Ovampoland (Omaramba); Southern Rhodesia (Plumtree); Transvaal (Waterberg, Zoutpansberg).

MELOË CAFFER, Péring.,
Trans. S. Afric. Phil. Soc., iii., 1886, p. 123.

Dark blue, somewhat purple on the head and prothorax, moderately shiny; head slightly wider than the prothorax at its widest part, deeply and irregularly scrobiculate punctate, and having in the centre a deep median groove reaching from the vertex to the central part and continued thence to the transverse groove; prothorax sub-quadrate, slightly narrower at base than at apex, the posterior angles are slightly rounded, the anterior lateral part is slightly ampliate with the outer angles rounded, the upper side is more deeply scrobiculate than the head, there is a very deep and broad median longitudinal groove and a parallel depression on each side of the disk; elytra divaricating at about one half of the length, and covered with longitudinal highly raised and greatly wavy carinate folds which are twice as narrow as the intervals; abdominal segments very closely shagreened; legs very briefly pubescent.

Length 10½–15 mm.; width 4–7 mm.

Hab. Natal (Durban, Maritzburg); Transvaal (Lydenburg).

MELOË HOTTENTOTUS, Péring.,
Plate XXII., fig. 4.
Trans. S. Afric. Phil. Soc., iii., 1886, p. 123.

Dark blue, moderately shiny; head broader than the prothorax and covered with deep sub-foveolate round punctures closely set and separated by a nearly smooth interval, there is no median groove in the vertex or above the epistome; antennæ long, reaching to about the median part of the elytra, the fifth, sixth, and seventh joints are broader than the others in both sexes, being very broadly dilated and hollowed underneath in the male; prothorax longer than broad, ampliate rounded laterally in front and having thus no distinct neck, not grooved longitudinally in the centre but having there an ill-defined smooth line covered with deep foveate punctures set close to each other especially in the anterior part, and transversely impressed along the base for about two-thirds of the width; posterior angles distinct; elytra divaricating past the median part, covered with sub-contiguous, raised wavy folds; abdomen shagreened.

Length 12–16 mm.; width 4–7 mm.

Hab. Cape Colony (Port Elizabeth); Natal (Durban, Maritzburg); Transvaal (Lydenburg).

SUB-FAMILY CANTHARINÆ.

A². Head transverse or quadrate; anterior part parallel, not cuneiform.

B². Mandibles prolonged, very sharp.

Labrum extremely short, mandibles very robust, unidentate inwardly; palps long.

Upper part of the claws pectinate.

Elytra covering the abdomen, not dehiscent along the suture .. .. HORIINI.

B¹. Mandibles not prolonged.

C². Antennæ arcuate, last joint thickened externally.

D². Upper part of the claws not pectinate.

Number of joints varying from eleven to seven; elytra not dehiscent at apex .. .. MYLABRINI.

C¹. Antennæ straight, last joint not thickened externally.

Number of joints eleven; elytra covering the abdomen but occasionally broadly rounded at the apex of the suture .. CANTHARINI.

D¹. Upper part of the claws pectinate.

Number of joints eleven; elytra not covering completely the abdomen, strongly sinuate laterally and dehiscent along the suture from near the scutellum .. .. SITARINI.

A¹. Head triangular, anterior part cuneiform.

Maxillary lobes slender, elongate or greatly prolonged and even setaceous ZONITINI.

Gen. SYNHORIA, Kolb.,

Kaf. Deutsch.-Ost. Afrikas, 1897, p. 256.

Arrow., Ann. and Mag. Nat. Hist., 8 ser., vol. ii., 1908, p. 204.

Mentum extremely narrow, transverse, palpigers broad, strongly developed, ligula nearly transverse, very short, briefly pubescent along the margin, labial palps very long, the intermediate one longer than the first and third taken together; maxillæ very short, the lower lobe supported by a broad and short palpiger is hardly distinguishable, the upper lobe is slender, fasciculate at the tip, slightly so inwardly, and projects very little beyond the basal joint of the maxillary palps the joints of which with the exception of the basal are very long, the apical one being somewhat fusiform and slightly truncate at tip; mandibles very robust, long (♀) or very long (♂) arcuate and each provided with a sharp, malar tooth; labrum rudimentary; head declivous, transverse, very broad or broad according to sexes, epistome very narrow, eyes large, sub-reniform, antennæ short, basal joint massive, knobby at tip, second smaller than the first but also knobby and more robust than the following ones, the first five of which are sub-turbinate, the others are slightly compressed, longer than broad, the last one being longer than the penultimate; prothorax twice as broad as long; scutellum very broad, acuminate at apex, rounded there; elytra elongate, as broad as the prothorax at the base, little convex, singly rounded at apex; legs compressed, moderately slender, tibiæ with very small spurs, tarsi long, hispidous underneath, claws robust, the upper side also robust, pectinate, but slender and simple at the hooked part, the lower filiform, not spatulate at tip.

The ♂ differs from the ♀ in the very great development of the head and mandibles, the latter being longer than the head, which is broader than the prothorax, and has on each side of the base a conspicuous callus-like process, and underneath close to the point of insertion of the antennæ a vertical, conspicuous tooth; the ligula has on each side a short, acute membranous lobe wanting in the ♀, in which sex the head is narrower than the prothorax, the labrum is more distinct, the eyes are more developed underneath; the mandibles are also projecting but do not compare in size with those of the ♂, and the elytra are nearly parallel laterally, whereas they are strongly sinuate past the middle in the ♂.

Found in the nests of several species of Carpenter Bees belonging to the genus *Xylocopa*. When captured these insects exude at the knees a considerable quantity of yellowish fluid.

Key to the Species.

A^2. Prothorax with a deep discoidal impression on each side; punctures on the upper side deep, very closely set; posterior angles of the head bulging out in the male.. .. .. *hottentota.*

A¹. Prothorax without any discoidal impression on each side; punctures on the upper side very fine and very closely set; posterior angles of the head not bulging out in the male .. .. *rhodesiana*.

SYNHORIA HOTTENTOTA, Péring.,
Plate XXII., fig. 2, 2*a*, 2*b*.
Trans. S. Afric. Phil. Soc., iv., 1888, p. 134.

Bright red, palpi, antennæ, tibiæ and tarsi black, apical part of the mandibles deeply infuscate. In the male the elytra have occasionally on each side a small juxta-scutellary and a sub-humeral black spot, two post-median spots or dots between the second costa and the outer margin, and a similar one above the apex in the first interval; these black spots are somewhat asymmetrical. Head deeply punctate and very briefly pubescent, the punctures are more closely set in the female than in the male, in the latter the basal part of the sides project strongly; prothorax deeply and closely punctate, and briefly pubescent, the pubescence, however, being longer laterally in the female than in the male, it is longer than broad in both sexes, in the male it is narrowly grooved in the centre from the base to a short distance from the apex and has on each side a deep impression, whereas in the female it is grooved from the base to the apex and is much less conspicuously impressed on each side of the disk; scutellum punctulate; elytra deeply punctulate, the punctures are almost contiguous, and the intervals slightly raised, thus imparting to the elytra a faintly shagreened appearance, the two dorsal costæ are very distinct, and the pubescence is very short, but very dense; under side and legs closely punctate, pubescent.

Length (excl. of mandibles) 21–32 mm.; width 6–11 mm.

Hab. Cape Colony (Cape Town, Worcester, Knysna); Natal (Durban); Damaraland (Goagas); Ovampoland.

Two examples from Damara are a little darker in colour than the Cape and Natal examples the males of which have also a longer pubescence on the prothorax.

SYNHORIA RHODESIANA, n. sp.

Male: Brick red with the apex of the mandibles, the antennæ, and the basal part of the femora black; head and prothorax not distinctly pubescent, the pubescence on the elytra is extremely fine, and the latter has two rudimentary fuscous, asymmetrical spot-like patches on each side near the base; head straight laterally behind the eyes, the longitudinal central groove is visible in the centre of the frontal part only, the punctuation is very fine and is to be seen only on the sides; prothorax very transverse, plainly pubescent laterally, covered with somewhat remote fine punctures

on the sides, slightly grooved longitudinally in the centre, and having no discoidal impression on each side of the groove; scutellum punctulate; elytra very closely aciculate, the two dorsal costæ are quite distinct; under side finely aciculate, very briefly pubescent.

Length (excl. of mandibles) 21 mm.; width 8 mm.

Hab. Southern Rhodesia (Umtali).

Tribe MYLABRINI.

Mentum ampliate rounded laterally, longer or as long as broad, attenuate in front; ligula elongated, much narrower than the mentum, corneous or membranaceous, dilated and deeply sinuated and densely pubescent in front; palps somewhat short; maxillæ robust, inner lobe (maxilla) with a broad, thick bunch of fulvous hairs, upper lobe (galea) moderately slender, somewhat compressed and as densely penicillate inwardly as the inner; labial palps short, ultimate one truncate; maxillary palps moderately long, robust, ultimate one cylindrical and truncate at tip, both palps hairy; mandibles sharply arcuate at tip, provided inwardly with a broad corneous membrane having a briefly pubescent edge, right mandible with a very distinct inner tooth at a short distance from the point; head slightly longer than broad, provided with large, barely incised eyes, epistome usually transverse, labrum long, sinuate in front; antennæ robust, short, arcuate, the number of their joints varying from eleven to seven, first joint short, more or less clavate, second very small, third longer or as long as the fourth, the intermediate transverse, more dilated inwardly than outwardly, last one always longer and thicker than the others, ovate or swollen outwardly and more or less sharply acuminate at tip; prothorax as long as broad, strongly attenuate in the anterior part, sub-parallel in the posterior, truncate at base, and only half as wide as the elytra; scutellum short, semicircular; elytra elongated, sub-cylindrical but slightly ampliated in the posterior part, singly rounded at apex, longer than the six-segmented abdomen, and with the shoulders rounded, the wings are present; intermediate coxæ situated far from the posterior, but set close to the anterior, both being longitudinal, while the posterior are transverse; legs very long; tarsi very long, slightly compressed, claws long, cleft into two, the upper part slightly more robust than the lower, and both simple.

The body of all the species is very hairy; the elytra, however, are less pubescent than the rest of the body. They are black or brown relieved by yellow or red patches and transverse bands, the punctuation of which, and also the colour of their pubescence, differs slightly from that of the background. These patches or bands invade occasionally the greater part of the surface, making it difficult to ascertain which is the right

colour. I have assumed in my descriptions that the background is black or dark brown.

The extreme variation in the disposition of these yellow or red markings makes the study of the species of this genus extremely difficult. Moreover, examples differ considerably in size, and the sculpture varies accordingly.

In order to facilitate the identification I have named and figured the varietal forms. There is little doubt that the habitat of several of these varieties might prove to be restricted to certain localities, in which case they will have to rank as species.

It is singular that in spite of the great range in the South African area of certain species or their varieties, such as *Mylabris oculata, M. alterna, Decatoma lunata, Ceroctis phalerata*, &c., only three, *i.e.*, *Mylabris holosericea, M. dentata*, and *Coryna argentata*, originally described from Senegambia, are occasional intruders.

The difference in the number of antennal joints has been made use of for dividing this tribe into sections, so as to facilitate identification. This difference is caused by the fusion of two or more of the penultimate joints with the ultimate one; these articles are thus merged into a thick ovoid or club-shaped one, in which the suture is, however, occasionally visible.

Key to the Genera.

A^5. Antennæ 11-jointed.

B^2. Prothorax strongly attenuate in front; elytra convex.

Inner part of intermediate antennal joints not strongly serrate .. *Mylabris.*

Inner part of intermediate antennal joints very strongly serrate .. *Ceroctis.*

B^1. Prothorax quadrate; elytra plane .. .. *Melinesthes.*

A^4. Antennæ 10-jointed .. .. *Decatoma.*

A^3. Antennæ 9-jointed.. .. .. *Coryna.*

A^2. Antennæ 8-jointed.. .. .. *Actenodia.*

A^1. Antennæ 7-jointed.. .. .. *Paractenodia.*

Gen. MYLABRIS, Fabr.,

Plate XXII., fig. 1.

Syst. Entom., 1775, p. 261, No. 78.

Antennæ 11-jointed, not strongly serrate inwardly.

Key to the Species.

A^2. Elytra with two transverse yellow or yellow and brownish red bands.

B. Head and prothorax clothed with a dense, black, non-silky pubescence.

C^2. Third basal antennal joint longer than the fourth.

D^2. Basal part of elytra not completely invaded by the dorsal and lateral yellow patches.

a[5]. Antennæ yellow with the two basal joints black or fuscous.

Basal part of elytra with a large yellow patch, and a very distinct lateral one; the two transverse bands broad, of nearly equal width throughout, hind border of the hind band very narrowly edged with rufous brown (pl. xxiii., fig. 1) .. .. *oculata.*

Basal part of elytra with a small dorsal spot and a lateral dot, hind border of the second posterior band very distinctly edged with rufous brown (pl. xxiii., fig. 2) .. .. var. *kakamas.*

Basal part of elytra with a small dorsal spot, and a minute lateral dot, posterior band narrowed from the median part to the outer margin, being there only half the width of the inner dorsal part, hind border broadly edged with rufous brown (pl. xxiii., fig. 3) .. .. var. *vulgaris.*

Basal part of elytra with two dots, anterior band covering almost half the length and connected laterally with the somewhat narrow posterior one from the outer margin to about the median part, the background along the suture being triangular and rufous brown, hind border of the posterior band very broadly edged with rufous brown (pl. xxiii., fig. 4) var. *transitoria.*

Basal part of elytra with a dorsal, moderately sized spot, and a lateral dot, anterior band equal in width to about one-fourth of the surface and not sinuate, post-median part with a broad rufescent band slightly wider than the anterior, and along the upper edge of which runs a narrow yellow band reaching from the suture to about the middle, and a small yellow spot close to the outer margin (pl. xxiii., fig. 5) .. .. var. *vicaria.*

Basal part of elytra with a broad dorsal and lateral yellow patch, the anterior band is very broad and yellow, the posterior one which is only half the width of the anterior is reddish, ovate towards the lateral margin, and somewhat narrowed towards the suture (pl. xxiii., fig. 6) .. .. var. *tricolor.*

Basal part of elytra with a moderately wide dorsal patch, and without lateral dot, anterior band yellow, narrower above the outer margin than towards the suture, posterior band, narrower than the anterior, reddish with its fore edge more or less broadly yellow towards the inner part (pl. xxiii., fig. 7) .. var. *amatonga.*

Basal part of elytra with a lateral yellow dot, no dorsal one, anterior band yellow, quite transverse, equal in width to two-fifths of the whole length, and almost contiguous with a very broad rufous brown band of nearly equal width (pl. xxiii., fig. 8) *hottentota.*

Basal part of elytra with a narrow, transverse or sub-ovate very small dorsal yellow patch and a lateral dot, anterior band narrow, slightly sinuate, and a little narrower near the outer margin than at the suture, posterior band rufescent, nearly twice as wide as the anterior, not sinuate (pl. xxiii., fig. 9) *myops.*

Basal part without dorsal or lateral patch or spot, two narrow yellow bands the posterior of which is slightly sinuose, and either of equal width, or slightly narrowed towards the outer margin (pl. xxiii., fig. 10) .. .. *bugueti.*

Basal part with an ovate dorsal yellow patch and a lateral spot, anterior band yellow, narrow, strangulated in the centre, posterior also yellow, and somewhat broadly interrupted in the centre (pl. xxiii., fig. 12) .. .. *hybrida.*

Basal part without dorsal or lateral patch or spot, anterior yellow band narrow, lower edge plainly bi-sinuate, posterior band orange yellow, somewhat slanting, broader than the anterior, widest in the centre, and with both edges plainly bi-sinuate (pl. xxiii., fig. 11) .. .. *versuta.*

a^4. Antennæ yellow with the three basal joints black.

Basal part of elytra with no lateral spot, and having a transversely ovate yellow dorsal patch, coalescing with the anterior yellow band which is broad, but narrowed from the margin to the suture, posterior one narrower than the anterior and considerably reduced in width from the middle to the outer margin, plainly bi-sinuate on each side, and separated from the anterior band by a very narrow space (pl. xxiii., fig. 13) .. .. *scalaris.*

Same as the type but with the two dorsal bands coalescing along the suture (pl. xxiii., fig. 14).

Basal dorsal spots separated from the anterior band, posterior band separated along the margin from the anterior (pl. xxiii., fig. 15).

a^3. Antennæ yellow with the four basal joints black.

No dorsal or lateral patch or spot, anterior band deep yellow and ascending greatly towards the base, very broad, lower edge slightly bi-sinuate, posterior band less broad than the anterior, anterior margin incised and narrowed from the middle to the outer margin (pl. xxiii., fig. 16) .. .. *tettensis.*

a^2. Antennæ yellow with the five basal joints black.

The five apical joints bright yellow.

Basal part of elytra with a transversely ovate patch, no lateral spot, anterior band yellow, narrow, broadening slightly along the margin, posterior band either not broader than the anterior and sinuose, or broadly dilated from the centre to the outer margin (pl. xxiii., figs. 17, 18) .. .. .. *plagiata.*

The same but with the posterior band suffused with orange, and three times as broad as the anterior; prothorax not coarsely punctate (pl. xxiii., fig. 19) .. *hæmacta.*

The same as *hæmacta*, but without any traces of basal dorsal patch; prothorax very coarsely punctate (pl. xxiii., fig. 20) .. .. var. ***hottentota.***

a^1. The five apical joints infuscate, almost black.

Basal part of elytra with an ovate rounded orange-yellow patch, no lateral one, bands orange yellow, anterior one narrow, strangulated in the centre, posterior one broader, slanting from the median dorsal part to the outer margin (pl. xxiii., fig. 21) .. *lavateræ.*

Basal part of elytra with an ovate rounded orange patch, no lateral one, bands of the same colour, anterior one interrupted in the centre, posterior strongly slanting, narrow from the suture to about the middle and dilated thence to the outer margin (pl. xxiii., fig. 22) .. .. *testudo.*

D^2. Elytra with a yellow basal band coalescing with the anterior band.

a^2. Antennæ yellow with the two basal joints black.

Elytra yellow from the base to the median part, but with three transversely disposed black spots of the background left at some distance from the base .. *tristigma.*

The same with a narrow post-median yellow band constricted or broadly interrupted in the centre (pl. xxiii., figs. 23, 24) .. .. var. *permutans.*

The same but with the two lateral and sub-median black spots in the anterior part coalescing so as to form a lateral patch, and the yellow basal part does not reach the median part (pl. xxiii., fig. 25) .. .. var. *flavicornis.*

Anterior part of elytra yellow from the base to near the median part, lower margin of the yellow band nearly transverse or with the rudiments of a post-median yellow band reduced to a juxta-sutural transversely ovate patch, and a minute supra-marginal yellow dot (pl. xxiii., figs. 26, 27).. .. var. *stăli.*

Anterior part of elytra yellow from the base to the median part, and slightly or distinctly prolonged beyond it along the suture and the outer margin (pl. xxiii., figs. 28, 29) .. .. *palliata.*

Elytra pale yellow with eight black patches on each side, head and prothorax conspicuously scabrose punctate (pl. xxiii., fig. 32) .. .. *connexa.*

*a*¹. Antennal joints black.

Elytra pale yellow from the base to five-sixths of the length, and having in the anterior part three transversely disposed small black dots (background) and a transverse post-median black band interrupted in the centre (pl. xxiii., figs. 30, 31) .. .. *tripunctata.*

C¹. Third basal antennal joint not longer than the fourth.

Elytra with two transverse yellow, yellow and brownish-red, or reddish transverse bands.

D¹. Basal part of elytra not covered by the coalescing dorsal or lateral patches and spots.

*a*¹. Antennæ yellow with the two basal joints black.

Basal part of elytra with a minute dorsal yellow spot, and a similar lateral spot, or without any at all, anterior band narrow, little sinuose, posterior one not much broader than the anterior, more or less plainly narrowed towards the outer margin, background from the hind margin of the anterior part to a short distance from the apex reddish brown (pl. xxiii., fig. 33) .. .. *alterna.*

Basal part of elytra with a minute yellow dot, anterior band yellow, narrow, somewhat constricted towards the outer margin, posterior band broader, dark brownish red, and somewhat indistinct (pl. xxiii., figs. 34–36) .. .. var. *irritans.*

No basal or lateral dot, a very narrow, once or twice interrupted transverse posterior band (pl. xxiii., fig. 37) .. .. var. *vibex.*

Basal part of elytra without dorsal or lateral spot, anterior band red, broad but narrowed in the lateral supra-marginal part, posterior one also red, as broad in the centre where it is ampliated behind as the anterior, and slightly notched in the anterior margin (pl. xxiii., fig. 38) .. .. *dicincta.*

Basal part of elytra with a dorsal yellow patch, and a smaller lateral one, two broad yellow bands of nearly similar width, the hind margins of which are only very slightly sinuose (pl. xxiii., fig. 39) .. *tripartita.*

The same, but with the two yellow bands separated by a very narrow space, the two bands coalescing at two points (pl. xxiii., figs. 40, 41) .. .. var. *makalanga.*

Basal part of elytra with a dorsal and a lateral yellow patch or not; anterior yellow band broad,

slightly narrowed near the outer margin; hind margin slightly or strongly bi-sinuate, posterior of nearly the same width as the anterior, the margins distinctly bi-sinuate, the hind one of the posterior one narrowly edged with orange-red (pl. xxiii., figs. 42, 43, 44) .. .. *matoppoena.*

A'. Elytra with a dorsal and a lateral patch, and two or three zigzagged transverse yellow or red bands.

B³. Head and prothorax with a long silky pubescence.

C. Third basal joint of antennæ longer or as long as the fourth.

D³. Elytra with a basal and a lateral longitudinal yellow bands prolonged respectively along the suture and the outer margin.

*a*¹. Antennæ with the two basal joints black, three to eight fuscous, nine to eleven flavescent.

*b*². Elytra without an apical transverse patch.

Whole upper side clothed with a dense silky grey pubescence; on the elytra, the dorsal pale yellow band reaches from the base to one-third of the length, the outer marginal one runs to the same length and unites with the anterior narrow, bi-sinuate dentate band, the posterior is slightly slanting, not wider than the anterior and equally sinuate dentate, or with the sutural longitudinal band, coalescing, except for a small dot left of the background with the anterior band (pl. xxiii., figs. 45, 46) *hilaris.*

The same, but anterior band broader and interrupted near the outer margin, posterior one unisinuate and broader at the suture than at the outer margin (pl. xxiii., fig. 47).. .. .. *pertinax.*

*b*¹. Elytra with an apical transverse patch.

Basal sutural band as in the previous species, lateral band continued as far as the second transverse band, which is much narrowed and subhamate near the outer margin, third band extending across the supra-apical part (pl. xxiii., fig. 48) .. *villosa.*

B². Head and prothorax clothed with a short, appressed, silky grey pubescence.

D². Elytra with a basal dorsal and a lateral patch or spot, and two transverse uneven bands.

*a*². Antennæ yellow with the three basal joints black.

Elytra black or fuscous black and with a narrow red outer margin broadening considerably past the postmedian band and apex and ascending the suture, a basal dorsal patch and an elongated lateral one, two narrow sharply bi-sinuate yellow transverse bands (pl. xxiii., fig. 50) .. .. *tincta.*

a^1. Antennæ yellow with the two basal joints black.

Elytra black, more or less broadly marginated all round and also along the suture with brownish red, base with a slanting yellow patch coalescing occasionally by means of a dorsal line with the anterior band, and a lateral patch, anterior and posterior bands narrow, with each margin bi-dentate (pl. xxiii., figs. 51, 61) .. .. *matabele.*

Elytra with an arcuate basal yellow patch reaching the suture, and an elongated lateral patch, anterior band narrow, the margins three dentate on each side, posterior band also three dentate, strongly narrowed towards the outer margin (pl. xxiii., fig. 52) *derosa.*

Base of elytra with a broad, semi-circular band, and a lateral, narrow, elongated patch, anterior band moderately narrow, slightly slanting from the outer margin to the suture, hind margin strongly bi-sinuate, posterior band transverse, narrowed in the centre; bands and patch light orange-red; under side densely clothed with a greyish silky pubescence (pl. xxiii., fig. 53) .. .. *pruinosa.*

Whole body covered with a dense, appressed greyish flavescent silky pubescence; a basal dorsal yellow spot, a supra-humeral, elongated patch or band reaching another, but diagonal, dorsal yellow band, lateral basal patch continued as a marginal band as far as the posterior band, the latter also slanting, and continued backwards along the margin to a short distance from the apex (pl. xxiii., figs. 54, 55) *burmeisteri.*

B^3. Head and prothorax clothed with a short appressed black pubescence.

a^1. Antennæ with all the oints black.

Base of elytra with three yellow patches disposed transversely, anterior band divided into three yellow patches, posterior band strongly zigzagged and usually narrowly interrupted above the outer marginal part (pl. xxiii., fig. 57) .. .. *sedecimguttata.*

Base of elytra with a dorsal arcuate yellow patch, and a small lateral one, anterior and posterior yellow bands narrow, both strongly zigzagged, anterior one occasionally narrowed on the side (pl. xxiii., figs. 58, 59) .. .. *picteti.*

B^2. Head and prothorax clothed with an erect, black pubescence.

D^1. Elytra with a third band, or apical spot.

a. Antennæ black.

Base of elytra with an ovate dorsal patch and a lateral one, anterior bands narrow, sinuate, inter-

mediate one slanting, bi-sinuate dentate on each margin, broader in the sutural than in the lateral part and connected along the suture with a diagonal supra-apical third band; all the bands and patches red (pl. xxiv., fig. 62) .. .. *cæca.*

Base of elytra with a red border, three sub-basal irregular pale yellow patches disposed transversely, median pale-yellow band narrow, strongly zigzagged, posterior one V-shaped, the V formed by two spurs connected with a supra-apical small central patch (pl. xxiv., fig. 63) .. .. *zigzaga.*

B[r]. Head and prothorax clothed with an erect, and more or less deeply flavescent pubescence.

Head, prothorax, and under side clothed with a dense flavescent pubescence; yellow bands of the elytra invading the greatest part of the surface leaving only a juxta-scutellary and a humeral black patch, three strongly zigzagged very narrow transverse bands and a supra-apical median spot connected with the posterior band (pl. xxiv., fig. 64) .. .. *dentata.*

Head, prothorax, and under side clothed with a greyish black pubescence; elytra with a broad basal yellow band with a supra-humeral black spot, the lower edge is plainly denticulate, two ante- and post-median transverse bands reaching from side to side, the first three-dentate on each side, the other nearly interrupted in the centre and also strongly dentate, an apical band formed of two connected patches, which are, however, occasionally separated (pl. xxiv., fig. 65) .. .. *lacerata.*

MYLABRIS OCULATA, Thunb.,
Plate XXII., fig. 1; XXIII., fig. 1.

Nov. Spec. Insect., vi., p. 114, pl. 2, figs. 11*a b*; Oliv., Entom., iii., 47, p. 4, pl. 11, figs. 11*a b*; Billb., Monogr., p. 47, pl. v., figs. 6–10; Mars., Monogr., p. 42, pl. iv., fig. 3.

Elongated, black, antennæ, with the exception of the two black basal joints, yellow; opaque, spots, and bands on the elytra light stramineous yellow; labrum, head and prothorax clothed with a dense, erect, black pubescence, under side similarly hairy; on the legs the pubescence is shorter, and in the inner part of the fore tibiæ it is slightly flavescent, with a silky sheen; the head and prothorax are covered with deep, closely but somewhat irregularly set punctures; on the elytra the punctures are nearly similar, but the black or dark brown background is more coriaceous than the bands, and densely but briefly hairy, the bands or spots are much more briefly hairy and the hairs are much scattered; the under side and legs are very closely aciculate; basal part of elytra with a dorsal, sub-transversely ovate yellow patch; under the humeral part, and reaching the outer margin, is a smaller, elongate-ovate patch of the same colour

occasionally impinging on the humeral part, the two bands are broad, or very broad, of nearly equal width, reaching from the sutural to the marginal fold, the hind border of the post-median band is slightly sinuate and occasionally moderately ampliated at about the median part, and is very narrowly brownish.

Length 23½–34 mm.; width 9–12 mm.

This species seems to be restricted to the southern part of the Cape Colony, and to Natal and Zululand; above that limit it seems to be replaced by, or merges into, the variety *vulgaris*.

Var. KAKAMAS,

Plate XXIII., fig. 2.

Shape, size, vestiture and livery of *M. oculata*, but easily distinguished by the deeper, coarser and scrobiculate punctures of the prothorax; the basal dorsal patch is reduced to a minute spot, and the lateral one to a mere dot; the two transverse bands are of nearly equal width throughout, very little sinuated, and both have the hind edge plainly brownish rufous.

Length 28–32 mm.; width 7½–9 mm.

Hab. This variety seems restricted to the dry, arid parts of the north-western part of the Cape Colony.

Var. VULGARIS,

Plate XXIII., fig. 3.

Shape, size, and livery of *M. oculata*, differs from the latter by the more closely set and more regular punctures on the head and prothorax; the large basal, dorsal patch on each elytron is reduced to a small yellow spot, and the lateral one to a dot, as in the var. *kakamas*, and the anterior transverse yellow band is as broad as in *M. oculata* with the borders hardly sinuate, the post-median band is transversely ampliate-ovate from the suture to about the median part, and continued thence to the outer margin as a slightly slanting band reduced to half the width of the median dorsal part; along the hind edge is a broad rufous brown border nearly half as broad as the yellow band at its widest part.

Length 32 mm.; width 11 mm.

Hab. The whole eastern part of Cape Colony, Natal, Transvaal.

Var. TRANSITORIA,

Plate XXIII., fig. 4.

Smaller than the var. *vulgaris;* sculpture of head and prothorax identical; on the elytra the basal dorsal and lateral spots are very small, the anterior band is however very broad, covering nearly half the length;

laterally it is connected from the outer margin to the median dorsal part with a much narrower band reaching from the suture to the outer margin, the slightly post-median space of the background left being in the shape of a broad, rufous brown triangle across the suture, the posterior band has a broad edge of rufous brown.

Length 21–23 mm.; width 7–8 mm.

Hab. Natal (Durban, Frere, Maritzburg).

Var. VICARIA,

Plate XXIII., fig. 5.

Shape, size and sculpture of the var. *transitoria;* differs by the shape of the elytral yellow bands; basal dorsal spot moderately large, lateral small, anterior transverse band broad, the width being about one-fourth of the length, the edges are not sinuate, the posterior band, instead of being entirely yellow, is rufous brown, of nearly the same width as the anterior, and edged in the fore part by a narrow yellow band reaching from the suture to about the middle; near the outer margin is a small yellow dot. This yellow anterior edging of the posterior band is probably uninterrupted in certain examples of this variety, but I have not as yet met with any such.

Length 24 mm.; width 7 mm.

Hab. Natal (Durban).

Var. TRICOLOR, Gerst.,

Plate XXIII., fig. 6.

Monatsb. Berl. Acad., 1854, p. 694; Peter's Reis., 1862, p. 297, pl. 17, fig. 11; Mars., Mon., p. 461, pl. 5, fig. 39.

Head and prothorax very finely punctulate; basal dorsal yellow patch transversely ovate, lateral one nearly as large, anterior band yellow, very broad, the width being equal to half the length, and the posterior edge is slightly bisinuate, the posterior band is red, only one-third of the width of the anterior, and slightly narrowed at the suture and at the outer margin which makes it look as if it were transversely ovate.

Length 29–31 mm.; width 11–12 mm.

Hab. Southern Rhodesia (Matoppos, Salisbury, Sebakwe), Mozambique (Lourenço Marquez, Beira).

Var. AMATONGA,

Plate XXIII., fig. 7.

Smaller than *M. tricolor*, sculpture and vestiture similar, the basal dorsal yellow patch is small, and the lateral one has disappeared; the anterior yellow band is much less broad than in *M. tricolor*, being at its

widest part only one-third of the length; from the suture to the second dorsal stria it is of equal width and gradually narrowed thence to the outer margin where it is one-fourth narrower than at the suture; the posterior band is transversely ovate and does not reach quite either suture or outer margin, it is rufescent, but the inner part of the fore edge is more or less broadly yellow.

Length 25–27 mm.; width 9–10 mm.

Hab. Amatongaland.

I have not recorded this species from anywhere but the Maputa River.

Var. HOTTENTOTA, Fähr.,
Plate XXIII., fig. 8.
Öfv. Vet. Ak. Förh., 1870, p. 341.

transversalis, Mars., Monogr., p. 400, pl. iv., fig. 2.

Closely allied to *M. tricolor*, but the basal dorsal patch is reduced to a tiny yellow dot, and the lateral one is obliterated; the anterior yellow band is very broad, the width being about equal to two-fifths of the length, the edges are not sinuate; this yellow band is separated from an equally broad rufous brown band of the same shape which is, however, occasionally somewhat narrower; in some examples the yellow and the rufous brown band coalesce.

Length 23–29 mm.; width 9–13 mm.

Hab. Natal (Durban, Tugela River).

Var. MYOPS, Fähr.,
Plate XXIII., fig. 9.
Öfv. Vet. Akad. Förh., 1870, p. 341; Mars., Monogr., p. 404, pl. 4, fig. 4.

Sculpture of the varieties *tricolor*, *hottentota*, &c., but usually smaller; basal dorsal patch very small, ovate or briefly transverse, yellow, like the very small lateral spot; anterior band yellow, narrow, being only equal to one-fifth of the whole length, slightly sinuate and slightly narrower at the outer margin than at the suture; at some distance from this anterior band is a post-median and much broader reddish brown one of nearly equal width reaching from the suture to the outer margin, and the edges of which are not sinuate.

Length 24–26 mm.; width 8½–10 mm.

Hab. Damaraland; Ovampoland.

I have seen a female example having a minute median yellow dot on the edge of the rufescent posterior band.

Marseul wrongly quotes Chevrolat as having described this species in Guérin's Iconogr., 1844, p. 123, pl. 35, fig. 4. The figure is undoubtedly that of *M. hæmacta*, Fairm., var. *namaqua*.

It is also probable that Făhræus' species is not identical with *M. myops*, Dej., *in litt.*, because the habitat of this species seems to be restricted to parts which had not been entomologically explored at the time of Dejean.

MYLABRIS BRUQUETI, Mars.,
Plate XXIII., fig. 10.
Monogr., p. 410.

Body very elongated; prothorax more deeply punctate than in the previous species, the punctures uneven and sub-scrobiculate in the posterior part of the disk; elytra piceous, each one with a minute basal dorsal yellow spot and no lateral one, or without the basal spot, anterior band yellow, narrow, not quite as broad near the outer margin as it is at the suture, posterior one either of the same width as the anterior or a little broader from the suture to about the middle, and narrowed thence to the outer margin, the width being reduced there to about one-half, the hind edge has either a very slender brownish margin, or a not very distinct, somewhat broad band of the same colour; legs and under side very closely aciculate.

Length 29–32 mm.; width 9½–10 mm.

Hab. Damaraland; Ovampoland.

Marseul (*loc. cit.*) has indicated rather than described the species.

MYLABRIS VERSUTA, n. sp.,
Plate XXIII., fig. 11.

Black; head and prothorax covered with moderately deep punctures separated by a smooth interval about equal to their own diameter; the pubescence long, dense, black; elytra without dorsal or lateral yellow patch, anterior band yellow, not broad, narrowed from about the median part to the margin, and with the hind border moderately deeply scooped out in the centre, posterior band orange-yellow, somewhat slanting, broader than the anterior, slightly scooped in the centre in the anterior margin, and emitting a short, blunt tooth in the middle of the hind one, which is also more sinuose.

Length 21 mm.; width 8½ mm.

Hab. Damaraland (Salem).

MYLABRIS HYBRIDA, Mars.,
Plate XXIII., fig. 12.
Monogr., p. 418, pl. iv., fig. 2.

Black, with the elytra brownish, turning to piceous in the posterior part; head and prothorax very closely punctate, especially the latter,

pubescence long, dense, black; elytra with a round, basal, dorsal yellow patch, and an elongated lateral spot, anterior band yellow, narrow, somewhat constricted in the centre, posterior one also yellow, not much wider than the anterior, broadly interrupted in the centre, and thus divided into a sutural and a marginal patch, the latter shorter and not quite as wide as the former; these spots and bands are edged with reddish brown.

Length 15–16 mm.; width 6 mm.

Hab. Damaraland.

Mylabris scalaris, Mars.,
Plate XXIII., figs. 13, 14, 15.
Monogr., p. 407, pl. iv., fig. 6.

Black; antennæ reddish yellow, with the three basal joints black, head and prothorax covered with closely set, moderately deep punctures, pubescence long, dense, black; elytra with a basal dorsal large orange-yellow patch somewhat transverse, but occasionally reaching the suture and coalescing there with the anterior band, no lateral spot; anterior band orange-yellow, very broad at the suture, but triangularly narrowed thence to the outer margin where the width is reduced by about one-third, the posterior band is narrower than the anterior, also broader at the suture, somewhat slanting towards the outer margin where it is also reduced in width by about one-third, and both the edges are bi-sinuate; the space separating the two bands is extremely narrow across the suture, and often the posterior is connected there with the anterior band.

Length 24–26 mm.; width 9–10½ mm.

Hab. Northern Damaraland.

Mylabris tettensis, Gerst.,
Plate XXIII., fig. 16.
Monatsb. Berl. Acad., 1854, p. 694; Peter's Reis., p. 298, pl. 17, fig. 12;
Mars., Monogr., p. 422, pl. iv., fig. 14.

Black; antennæ yellow, with the four basal joints black; head and prothorax covered with round punctures separated from each other by a quite smooth interval equal to their own diameter; the pubescence is long and erect, but not very dense, and in the frontal part the impressed line is hardly distinct; elytra without dorsal or lateral basal patch or spot, the anterior band, which ascends in the median part towards the base, is very broad, orange-yellow, and the hind border is slightly bi-sinuate, the posterior is not quite as broad as the anterior, and its width is narrowed laterally by one-third, the hind border is sinuose.

Length 26 mm.; width 9 mm.

Hab. Mozambique (Beira).

MYLABRIS PLAGIATA, Pall.,

Plate XXIII., figs. 17, 18.

Icon., p. 77, pl. E, fig. 3*a*; Mars., Monogr., p. 405, pl. iv., fig. 5.

oculata, Billb., Monogr., p. 46, pl. 5, figs. 6–10.
thunbergi, Cast., Hist. Nat. Ins., ii., p. 269.

Black, with the patches and bands on the elytra bright yellow; between the two transverse bands of the elytra is a juxta-sutural longitudinal rufescent band reaching from the suture to the centre; antennæ bright yellow, with the five basal joints black; head and prothorax coarsely punctate, the impressions on the latter very deep, pubescence long, dense, black; elytra each with a more or less rounded dorsal basal patch, but without any lateral one, anterior band narrow, broadening slightly along the outer margin, the edges little sinuate, posterior band either very little wider than the anterior, a little acuminate at both ends and plainly bi-sinuate on each border (fig. 17), or broadly dilated laterally, where it is twice the width of the part abutting near the suture (fig. 18). The pubescence of the under side is black, but in the varietal form it is greyish flavescent.

Length 22–24 mm.; width 8 mm.

Hab. Cape Colony (Worcester, Hex River, Prince Albert, Paarl, Ceres, Beaufort West).

MYLABRIS HÆMACTA, Fairm.,

Plate XXIII., fig. 19.

Ann. Soc. Ent. Fr., 1888, p. 198.

Head and prothorax still more coarsely punctate than in *M. plagiata;* the two basal antennal joints are black, and the other three infuscate, the impressions on the prothorax are very distinct, and the pubescence is dense and black; on the elytra there is no basal dorsal yellowish patch; the anterior band is very narrow, not sinuate, pale yellow edged with a sub-orange-brown narrow border, the posterior band is orange-yellow, strongly slanting, and in width a little more than two-fifths of the length with the borders not sinuate, the anterior edge has a narrow, sub-orange-brown border.

Length 25 mm.; width 8 mm.

Hab. Cape Colony (Kakamas).

Var. NAMAQUA,
Plate XXIII., fig. 20.

oculata, Guér., Icon. Règn. Anim. Ins., 1844, p. 133, pl. 35, fig. 4.
myops, Mars., Monogr., p. 404, pl. iv., fig. 4.

This variety so closely resembles *M. lavateræ* that it might be taken for the latter in spite of a difference in the shape of the markings of the elytra, the bands and spots of which are however of the same colour, but the antennæ are plainly yellow with the five basal joints black instead of being entirely fuscous black; head and prothorax very finely and closely punctate, the punctures however are irregular, impressions on the disk very plain; elytra with a rounded dorsal basal yellow patch, no lateral, anterior band moderately narrow, the edges suffused with orange, posterior band very broad, not slanting, orange-yellow, the edges hardly sinuate, but the hind one slightly rounded.

Length 27 mm.; width 10 mm.

Hab. Cape Colony (O'Kiep, Namaqualand).

MYLABRIS LAVATERÆ, Fábric.,
Plate XXIII., fig. 21.

Syst. Eleuth., ii., 1801, p. 83; Billb., Monogr., p. 10, pl. 1, fig. 7; Mars., Monogr., p. 45*a*, pl. v., fig. 38.

pustulata, Thunb., Diss. Ins. Nov. Sp., vi., p. 114; Oliv., Ent., iii., 47, p. 4, pl. 1, fig. 1.

Head and prothorax very closely punctulate, the punctures small, deep but uneven; the five antennal basal joints black, the others black, opaque, or very darkly fuscous; pubescence on the head and prothorax dense, long, black; elytra with an ovate orange-yellow basal dorsal patch, the anterior band is somewhat narrow, incised on each side in the middle but the lower incision is the deeper of the two, or it is broader but the lateral part, from the incision to the outer margin, is narrower than the part abutting on the suture, posterior band also orange-yellow, broader than the anterior, slanting from the median dorsal part to the outer margin, hind border sub-sinuate or uni-sinuate.

Length 23–25 mm.; width 8 mm.

Hab. Cape Colony (Paarl, Ceres, Tulbagh, Worcester).

MYLABRIS TESTUDO, Mars.,
Plate XXIII., fig. 22.
Monogr., p. 462, pl. v., fig. 40.

Black, elytra with a longitudinal, nearly median, rufescent zone reaching from the anterior to the posterior transverse bands, pubescence

black above, ashy flavescent and silky underneath; the five basal antennal joints black, the others deeply fuscous, nearly black; elytra each with a more or less rounded orange-yellow patch, no lateral spot, anterior band also orange, interrupted in the centre, and thus divided into an ovate patch near the suture and a triangular one the base of which extends along the outer margin; posterior band narrow and transverse from the suture to the centre, and with the lower part developed into a more or less quadrate patch reaching the outer margin. The livery is not unlike that of *M. plagiata*, but the colour of the antennæ easily differentiates the two.

Length 19 mm.; width 6½–7 mm.

Hab. Cape Colony (Victoria West, Beaufort West).

MYLABRIS TRISTIGMA, Gerst.,

Monatsb. Berl. Acad., 1854, p. 694; Peter's Reis., 1862, p. 299, pl. 17, fig. 5; Mars., Monogr., p. 429, pl. 4, fig. 19.

Black, clothed with black hairs on the under side, the legs, head, and prothorax; antennæ yellow with the two basal joints black, third joint not much longer than the fourth, but cylindrical; the anterior part of the elytra from the base to slightly past the median part is light straw-yellow, but at about one-half of the distance between the base and the hind margin are three small, transversely situated round spots, the hind margin is more or less strongly bi-sinuate; the yellow part is somewhat densely pubescent, the pubescence being black and erect.

This typical form seems to be the rarest, and I have not met with it.

Length 17½ mm.

Hab. Mozambique.

Var. PERMUTANS,

Plate XXIII., figs. 23, 24.

Like the type, but in addition to the anterior bands which have by coalescence invaded the whole anterior part of the elytra, except for the three round spots of the colour of the black ground which remain as vestiges of the part that divided the original two bands, there is a posterior narrow, yellow band, either strongly strangulated (pl. xxiii., fig. 24), or as often as not interrupted in the centre, and thus reduced to two patches (pl. xxiii., fig. 23), a juxta-sutural and a juxta-outer marginal one, divided by a very narrow or narrow interval.

Length 16–23 mm.; width 6–7 mm.

Hab. Southern Rhodesia (Salisbury, Mazoe, Matoppos).

Var. FLAVICORNIS, Fåhr.,
Plate XXIII., fig. 25.
Öfv. Vet. Akad. Förhdl., 1870, p. 342.

bipartita, Mars., p. 427, pl. iv., fig. 17.

The livery resembles that of *M. tristigma;* elytra suffused with yellow from the base to two-fifths of the length only, instead of past the middle; in this yellow part the median and the outer marginal black spot have coalesced so as to form a very distinct black transverse patch; the hind border is slanting from the margin to the suture, and is weakly bi-sinuate; the posterior band is reduced to two yellow spots of a moderate size, one juxta-sutural, and the other much smaller, situated near the edge of the outer margin. It is probable that the size of these two spots is variable.

Length $14\frac{1}{2}$–19 mm.; width $5\frac{1}{3}$–7 mm.

Hab. Natal (Durban).

Var. STÅLI, Fåhr.,
Plate XXIII., figs. 26, 27.
Öfv. Vet. Ak. Förhdl., 1870, p. 343.

Black, covered with a long, black pubescence; antennæ yellow with the two basal joints fuscous or black, third joint longer than the fourth; head and prothorax closely punctate; elytra shagreened. Elongated; elytra piceous or piceous rufescent along the suture; the whole of the anterior part is yellow from the base to two-fifths of the length, the hind border is slightly slanting from the outer margin to the suture, and there is either no distinct post-median yellow band or patches, or a distinct sub-juxta-sutural one and a minute supra-marginal dot on the posterior part.

Length 15 mm.; width 6 mm.

Hab. Natal (Eshowe, Karkloof, Durban).

MYLABRIS PALLIATA, Mars.,
Plate XXIII., figs. 28, 29.
Monogr., p. 432, pl. iv., fig. 22.

Smaller and more elongated than *M. bipartita;* it is easily distinguished by the antennal joints, the intermediate ones of which are much more closely set and not turbinate as in the latter. Head with a conspicuous median longitudinal frontal smooth line; both the head and prothorax are deeply and closely punctate, the punctures rugose, especially on the disk; the pubescence is black and long; elytra plainly coriaceous or sub-shagreened; the anterior part is dull orange-yellow from the base to the median part and occasionally beyond it, and the hind border is strongly

tri-sinuate, the outer marginal angle extending sometimes considerably further than the sutural (fig. 28); occasionally this border is produced into a short ramus, dilated at apex towards the median part, and is interrupted along the outer margin (fig. 29).

Length 13–14 mm.; width 5–5½ mm.

Hab. Southern Rhodesia.

MYLABRIS TRIPUNCTATA, Thunb.,
Plate XXIII., figs. 30, 31.
Diss. Nov. Ins. Spec., vi., p. 112; Billb., Monogr., p. 29, pl. 3, figs. 14–16; Mars., Monogr., p. 486, pl. v., fig. 49.

Black, clothed with a dense black pubescence; antennal joints black, third joint nearly twice the length of the fourth; head and prothorax finely and closely aciculate punctate, frontal line indistinct; elytra light yellow, the yellow colour having invaded the background to such an extent that the black background is reduced to three small black spots disposed somewhat diagonally in the anterior part; past the middle are two black patches of the same colour which vary in size, but the outer or marginal is larger than the juxta-sutural, and at the apex there is left a moderately broad, sinuate black band of the original colour; the elytra are coriaceous, and each bears three distinct costules.

Length 15–20 mm.; width 5–6½ mm.

Hab. Cape Colony (Stellenbosch, Worcester, Paarl, Malmesbury, Namaqualand, Beaufort West).

MYLABRIS CONNEXA, Mars.,
Plate XXIII., fig. 32.
Monogr., p. 505, pl. v., fig. 58.

Black, somewhat opaque; head and prothorax very closely scabrose punctate, frontal part with a small smooth patch, pubescence black, dense, erect; antennæ yellow, with the two antennal joints black, the intermediate joints closely set, third plainly longer than the fourth; elytra very closely punctate, the punctures deep but not rugose, the pale straw-like colour has invaded the greatest part of the area, leaving however on each side along the outer margin a long humeral black band, a median and a post-median patch of moderate size, and a small apical sutural one; on the disk are two patches, one anterior and one post-median, a small median dot in the centre of the disk, and close to it a very short transverse black patch astride the suture, which spot and patch are probably coalescing occasionally.

Length 10–14 mm.; width 6 mm.

Hab. Cape Colony (Stellenbosch, Paarl, Worcester).

MYLABRIS ALTERNA, Cast.,
Plate XXIII., fig. 33.

Hist. Natur. Ins., ii., 1840, p. 270; Mars., Monogr., 1873, p. 410, pl. iv., fig. 8.

Black, moderately shiny; head and prothorax very closely punctate, the punctures round, nearly contiguous, the pubescence black, dense, erect; on the frontal part the smooth, raised line is very plain, and the impressions on the prothorax are very marked; antennæ bright yellow, with the two basal joints black, the third one not appreciably longer than the fourth; elytra closely coriaceous and briefly pubescent, on the basal part is a small yellow dorsal spot, as often as not quite obliterated, but no lateral one; before the median part is a yellow transverse narrow band of nearly equal width throughout, the hind border of which does not reach the median part; past the median part is another transverse yellow band nearly equal in width to the anterior one but occasionally narrowed towards the outer margin; the dorsal space from the hind border of the anterior band to a short distance from the apex is rufescent brown except for a narrow space along the outer margin.

Length 18–26 mm.; width 6½–9 mm.

Hab. Cape Colony (Seymour, East London), Natal and Transvaal (probably the whole of these two territories).

Var. VIBEX,
Plate XXIII., fig. 37.

Closely resembles the type form, but differs in the markings of the elytra; the basal spots are entirely obliterated, the ante-median yellow band is normal, but the post-median is very narrow and interrupted shortly before the median part. This variety is very rare.

Length 20 mm.; width 7 mm.

Hab. Natal.

Var. IRRITANS,
Plate XXIII., figs. 34, 35, 36.

Resembles the type, but the posterior yellow band is completely obliterated, and is replaced by a dull rufescent one seldom reaching the outer margin; there is occasionally a minute yellow dorsal basal dot, and the first yellow band, which is of nearly equal width in the male, is broader and narrowed towards the outer margin in the female.

Length 21–26 mm.; width 8–10 mm.

Hab. Natal (Durban).

Mylabris dicincta, Bertol.,
Plate XXIII., fig. 38.

Nov. Commn. Act. Bonon., x., 1849, p. 419; Mars., Monogr., p. 408, pl. iv., fig. 7.

bizonata, Gerst., Monatsb. Berl. Ak., 1854, p. 694; Peter's Reis., 1862, p. 298, pl. 17, fig. 13.

Black, shiny; head and prothorax very closely punctate, the punctures nearly contiguous and somewhat rugose laterally on the prothorax, pubescence dense, black, frontal part with a plain, smooth line; antennæ bright yellow, with the two basal joints black, third joint not longer than the fourth; black background of elytra plainly shagreened, the red bands deeply and irregularly punctate, but with the space between the punctures not rugose, the third costule is obliterated from near the median part; there are two orange-red transverse bands reaching from side to side, and both slightly narrowed from the median dorsal part towards the outer margin, the posterior band is notched in the centre of the anterior border, and somewhat ampliated towards the centre in the posterior.

Length 27½ mm.; width 9–10 mm.

Hab. Southern Rhodesia (Salisbury, Sebakwe, Mozambique).

Mylabris tripartita, Gerst.,
Plate XXIII., fig. 39.

Monatsb. Berl. Acad., 1854, p. 694; Peter's Reis., 1862, p. 299, pl. 17, fig. 14; Mars., Monogr., p. 430, pl. 4, fig. 20.

Black; head and prothorax almost contiguously aciculate; pubescence dense, black; frontal part without any distinct traces of a longitudinal smooth line, antennæ yellow with the two basal joints black, and the third not longer than the fourth; elytra coriaceous except on the yellow bands, there is on each side a dorsal, either small or large basal pale yellow patch, a small lateral one, and two pale yellow bands; the anterior one is either broader or slightly broader than the second, but both are very little sinuate, the edges being mostly always nearly straight. In general appearance and coloration this species somewhat resembles small examples of *M. oculata*.

Length 20 mm.; width 7 mm.

Hab. Southern Rhodesia (Salisbury).

Var. makalanga,
Plate XXIII., figs. 40, 41.

Size, shape and sculpture of the type form *M. tripartita;* differs however from the type in having the two transverse yellow bands on the

elytra broad and separated from each other by a narrow line-like space (fig. 40), or the two bands coalesce, leaving only two or more minute spots of the colour of the original background (fig. 41); the hind edge of the posterior band is weakly sinuate.

Length 19 mm.; width 7 mm.

Hab. Southern Rhodesia (Salisbury).

MYLABRIS MATOPPOENA,
Plate XXIII., figs. 42, 43, 44.

Black, shiny; head and prothorax very closely aciculate; pubescence dense, black, frontal part with a distinct smooth elongated spot; elytra with a basal, dorsal yellow patch and a small lateral dot, or entirely without traces of either, the two somewhat dark yellow bands are broad, the anterior is narrower at the outer margin than on the suture, and with the hind border either not sinuate or slightly tri-sinuate, posterior band either narrowed also towards the outer margin or not, and with the anterior border plainly tri-sinuate, the hind one slantingly emarginate near the suture, and slightly sinuate near the median part, both the posterior borders are narrowly edged with reddish brown.

This form greatly resembles specimens of *M. oculata* of moderate size.

Length 25–27 mm.; width $8\frac{3}{4}$–9 mm.

Hab. Southern Rhodesia (Salisbury, Matoppos).

MYLABRIS PERTINAX, n. sp.,
Plate XXIII., fig. 47.

Black, clothed on the upper and under side with a long, greyish flavescent silky pubescence nearly as long on the elytra as on the head and prothorax; antennæ black, with the five apical joints fuscous and faintly flavous; head and prothorax very faintly aciculate and having a plain elongated frontal smooth patch; prothorax very closely aciculate, the punctures very closely set and round; elytra equally shagreened on the background and on the yellow bands, each with a long dorsal pale yellow band reaching from the base to one-third of the length, a median, transverse, bi-dentate one narrowly interrupted near the outer margin where there is a triangular part connected with a lateral narrow band reaching the base, and a posterior broadly triangular between the suture and the median discoidal part, and narrow thence to the outer margin, where it expands a little along the edge. Possibly a varietal form of *M. hilaris*.

Length 10–11 mm.; width 4 mm.

Hab. Southern Rhodesia (Victoria Falls), Natal (Durban).

MYLABRIS HILARIS, Pér.,
Plate XXIII., figs. 45, 46.
Trans. S. Afric. Phil. Soc., vi., 1892, p. 63.

Size, colour, sculpture and pubescence similar to that of *M. pertinax* and *M. villosa*, the dorsal very pale yellow band reaches also to one-third of the length, but it occasionally coalesces with the anterior transverse band, this band being connected laterally with a narrow yellow marginal one reaching the base, the anterior edge of the transverse band is deeply emarginate in the centre, the posterior is plainly bi-incised there, and reaches also the outer margin, expanding there alongside of it so as to be slightly connected there with the anterior; it is slightly slanting from the suture, the fore border is sinuate near the suture and incised in the centre, the hind border is bi-incised. When the dorsal longitudinal band meets the anterior transverse one, there is a small dot of the background still left visible.

Length 10½–12 mm.

Hab. Ovampoland.

MYLABRIS HOLOSERICEA, Klug,
Plate XXIII., fig. 48.
Erm. Reis., 1835, p. 31; Mars., Monogr., p. 142, pl. v., fig. 56.
villosa, Fähr., Öfv. Vet. Ak. Förhdl., 1870, p. 345.

Black, clothed on the upper and under sides with a dense silky flavescent pubescence; antennæ black fuscous, but with the five apical joints slightly flavous; head and prothorax closely aciculate; elytra elongated, narrow, each with a narrow pale yellow marginal band reaching from the basal part of the shoulder to a very short distance from the apex, in the anterior part is a longitudinal dorsal band reaching to about one-third of the length, the anterior transverse band is reduced to a transverse patch broadly separated from the outer margin, the posterior band is moderately broad, sub-transverse from the suture to the median dorsal part and narrowed thence to the outer margin in which it merges; on the rounded part of the apex extends a transverse yellow patch narrowly divided from the suture and the posterior and lateral margins.

Length 12 mm.; width 4 mm.

Hab. Southern Rhodesia (Salisbury).

Occurs also in Senegambia.

MYLABRIS TINCTA, Erichs.,
Plate XXIII., fig. 50.
Wiegm. Arch., 1843, i., p. 256.
Mars., Monogr., p. 171, pl. v., fig. 61.

Black, covered on the head and prothorax with a long, dense, thick silky flavescent pubescence which is also moderately dense but very short on the black parts of the elytra, and somewhat more sparse and intermixed with a few black hairs on the sub-orange-yellow bands; antennæ of the normal Mylabrid shape, and with the four basal joints black, the others flavescent red; head and prothorax covered with very closely set, slightly rugose punctures; the short frontal median ridge is quite distinct, and the post-median narrow longitudinal impression quite deep; the elytra are covered with contiguous, somewhat deep punctures with subrugose walls imparting to them a moderately rough, shagreened appearance, the basal dorsal patch is round, or very slightly slanting and free, the lateral is elongated, but does not, in my examples, reach beyond the length of the dorsal patch, the juxta-median transverse band is narrow, but broader towards the suture than towards the outer margin with the fore border deeply notched twice and the posterior still more deeply incised; the post-median band is quite similar, and both reach only the edge of an outer marginal red band beginning at the apex of the lateral elongated patch, and increasing in width below the posterior transverse band, greatly enlarged at the apical part and ascending along the suture, where it is however not wider than on the anterior part of the outer margin.

Length 13–14½ mm.; width 5½ mm.

Hab. Damaraland (Walfish Bay, Svakop River).

MYLABRIS MATABELE, n. sp.,
Plate XXIII., figs. 51, 61.

Black, clothed on the under side with an appressed thick silky flavescent pubescence equally dense on the head and prothorax; elytra rufous brown, maculated with fuscous, or with the greatest part of the disk fuscous, but the margin and the suture are narrowly reddish brown, bands and patches light orange-yellow; antennæ rufescent yellow with the two basal joints black, third joint very slightly longer than the fourth; head and prothorax very closely and deeply punctate, the punctures uneven especially on the sides of the prothorax; elytra closely coriaceous, each with a basal dorsal yellow patch and a very distinct lateral one, an ante-median band reaching from the suture to the margin, somewhat narrow and with both edges bi-incised, posterior band of nearly equal width; the basal dorsal patch does occasionally emit a spur connecting

it with the anterior band which, like the posterior, has both margins very deeply incised, and both are broadly disconnected from the outer margin. In some examples the fuscous dorsal part is divided into three superposed patches.

Length 12–13 mm.; width 5½–6 mm.

Hab. Southern Rhodesia (Matoppos); Bechuanaland (Moroqueng, Kenya).

MYLABRIS DEROSA, n. sp.,
Plate XXIII., fig. 52.

Black, covered with a dense, appressed, silky, flavescent pubescence on the under side, head, and prothorax; antennæ rufescent yellow with the two basal joints black, the third joint slightly longer than the fourth; head and prothorax very closely and finely punctate, the former with a very indistinct frontal smooth macule, the latter with a deep median discoidal impression; background of elytra very deeply and closely punctate, the punctures somewhat roughened, giving the appearance of a slightly shagreened surface, the yellow bands and patches are coriaceous only, on each side is a basal dorsal lunule the arcuate part of which reaches the suture, and a moderately large lateral patch, the anterior band reaches from the suture to the outer margin, the anterior border is shallowly bi-incised, the posterior plainly tri-dentate; the post-median band is broad along the suture, and tapers strongly from the centre to the outer margin, the fore border is deeply tri-sinuate, and the hind one bi-sinuate.

Length 14–14½ mm.; width 6 mm.

Hab. Transvaal (Pietersburg).

MYLABRIS PRUINOSA, Gerst.,
Plate XXIII., fig. 53.

Monatsb. Berl. Acad., 1854, p. 694; Peter's Reis., 1862, p. 302, pl. 18, fig. 2; Mars., Monogr., p. 443, pl. iv., fig. 28.

Under side, head, prothorax, and scutellum clothed with a very dense, appressed, silky, light flavescent pubescence; antennæ rufescent yellow with the two basal joints black, third joint as long as the fourth, and both sub-cylindrical; in addition to the appressed flavescent hairs the head and prothorax bear some erect black hairs; head and prothorax very closely punctate, the former with a distinct frontal longitudinal raised line; elytra strongly coriaceous even on the orange-yellow patches or bands, with the pubescence somewhat long, flavescent and greyish, each elytron with a large, rounded basal dorsal band, and a lateral elongated patch, the moderately narrow anterior band is slightly slanting from the

outer margin to the suture, and its hind border is very deeply bi-sinuate, posterior band of the same width, moderately deeply emarginate in the centre of the anterior border, and moderately arcuate in the posterior.

Length 14 mm.; width 5½ mm.

Hab. Rhodesia, Feira; Zambesi River; Victoria Falls.

MYLABRIS BURMEISTERI, Bertol.,

Plate XXIII., figs. 54, 55.

Nov. Comm. Ac. Bon., x., 1849, p. 420, pl. 9, fig. 8; Mars., Monogr., p. 437, pl. iv., fig. 24.

Black, with the upper side, the head, prothorax, and scutellum thickly clothed with a greyish flavescent pubescence, elytra covered with a similar pubescence, but so arranged in well-preserved examples that the sculpture shows as distinct fossulate punctures; antennæ rufescent yellow with the two basal joints black, the third of nearly equal length with the fourth; head and prothorax deeply pitted; elytra each with a basal dorsal, sub-juxtasutural yellow patch, a supra-humeral, sub-basal elongated one, the apex of which is very close to if not connected with two small patches disposed diagonally from the median part towards the suture, and as often as not having coalesced so as to form a diagonal band, the basal lateral patch is continued as a narrow band from the humeral angle to, but not connected with, a transverse post-median band, occasionally narrowly interrupted in the centre, and reaching from the suture to the outer margin, where it is prolonged backwards as a narrow band stopping short of the rounded part of the apex.

Very distinct from all the other South African species owing to its livery and the disposition of the yellow bands.

Length 11½ mm.; width 15 mm.

Hab. Cape Colony (Kimberley, Douglas); Transvaal (Rustenburg).

MYLABRIS SEDECIMGUTTATA, Thunb.,

Plate XXIII., fig. 57.

Diss. Nov. Insect. Sp., vi., p. 115, fig. 20; Billb., Monogr., p. 42, pl. 5, fig. 1; Mars., Monogr., p. 479, pl. v., fig. 47.

Black, moderately shiny, densely but briefly pubescent, the pubescence black, not shiny; antennæ black, the third joint one-third longer than the fourth; head and prothorax very closely punctured, the former is without any frontal smooth spot or line, the latter is one-fourth broader than long, ampliate rounded laterally in the anterior part, and truncate in front, the central and basal impressions are distinct, but there are no traces of a longitudinal smooth or raised line; elytra somewhat short and massive,

very closely punctate, coriaceous shagreened, each bears three basal small yellow patches disposed transversely, the first two are dorsal, the third lateral; towards the median part are three similarly disposed, but slightly wider patches, and the posterior band consists of a strongly zigzagged band reaching from the suture to past the middle dorsal part, and of a small supra-marginal patch closely approaching the remainder of the band, and probably occasionally coalescing with it; all these patches and band are narrowly edged with brown.

The shape of the prothorax in this species, and in the following, differs from that of the other South African Mylabris.

Length 18–21 mm.; width 8–9 mm.

Hab. Cape Colony (Port Elizabeth, Grahamstown, Knysna, Sunday's River).

Mylabris picteti, Mars.,

Plate XXIII., figs. 58, 59.

Monogr., p. 480, pl. v., fig. 48.

Allied to the preceding species; black, with the elytra brown, antennæ also completely black, the patches and bands of elytra lighter yellow; shape of head and prothorax similar, but the punctuation is deeper, the walls of the punctures are raised and irregular, the pubescence is also shorter, the discoidal part of the prothorax is deeply depressed, and the median longitudinal line is very distinct; on the elytra which are almost shagreened, the two basal dorsal patches have coalesced, as have also the three patches in the median part which have thus become a moderately narrow band both edges of which are deeply tri-sinuately incised; occasionally however this band is very narrowly interrupted towards the side; the posterior band is tapering from the middle to the outer margin, and strongly zigzagged there.

Length 16–17 mm.; width 6¼ mm.

Hab. Transvaal (Pretoria, Rustenburg).

Mylabris coeca, Thunb.,

Plate XXIV., fig. 62.

Diss. Nov. Insect. Sp., vi., 112, 1791, figs. 11–12; Billb., Monogr., p. 34, pl. 4, figs. 6–9.

ochroptera, Gmel., Edit. Lin., i., 4, p. 2020.

picta, Oliv., Ent., iii., 42, p. 9, pl. 1, fig. 3; Billb., Mon., p. 23, pl. 2, fig. 14; Mars., Monogr., p. 487, pl. v., fig. 40.

Black, clothed with a dense, black pubescence, antennæ completely black, third joint longer than the fourth, both very elongated; elytral

patches and bands orange-red; pubescence black, erect; head and prothorax deeply punctate, the punctures uneven and very closely set; elytra with the black background very closely aciculate, the spots and bands with irregularly scattered punctures; elytra elongated, each with an elongate ovate basal dorsal patch, and a smaller lateral one, the anterior band is somewhat narrow with the anterior margin straight, and the posterior deeply bi-sinuate, the second band is slanting from the suture to the outer margin, and expanding towards the sutural part is connected along it with another slanting supra-apical band reaching the outer margin, the anterior edge of the second band is broadly scooped laterally, the posterior edge is bi-dentate; both edges of the supra-apical band are nearly straight.

Length 15 mm.; width 6 mm.

Hab. Cape Colony (Worcester, Tulbagh, Paarl, Ceres, Stellenbosch, Namaqualand).

MYLABRIS ZIGZAGA, Mars.,
Plate XXIV., fig. 63.
Monogr., p. 466, pl. v., fig. 41.

Black, clothed with a short, black pubescence, antennæ entirely black, the intermediate joints somewhat conical but not sharply acuminate inwardly, third joint one-third or more longer than the fourth; head and prothorax covered with nearly contiguous, somewhat deep punctures, the prothorax is well attenuated into a neck, and the median line is very plain; elytra with the black background covered with sub-contiguous deep punctures all very briefly setiferous, but very sparsely scattered on the pale yellow spots and bands; the base has a broad orange-red border, below this are three patches of which the two dorsal ones are ovate, the lateral extends along the margin; the ante-median band is very narrow, strongly zigzagged owing to the deep scooping of both edges; the posterior one consists of a transverse patch sending a narrow spur connected with an elongated supra-apical patch which is connected in the same manner with the other portion of the posterior band which abuts on the outer margin.

This very distinct South African species was captured by Professor H. W. W. Pearson, in German South-West Africa, feeding on the inflorescences of that extraordinary plant, *Welvitschia mirabilis.* It is also found on the Nara melon *Acanthosycios horrida.*

Length 17 mm.; width 5½ mm.

MYLABRIS DENTATA, Oliv.,
Plate XXIV., fig. 64.

Encycl. Méth., viii., 1811, p. 97 ; Mars., Monogr., p. 496, pl. v., fig. 52.

tortuosa, Erichs., Wiegm. Arch., 1843, i., p. 256.

Black, clothed on the head, prothorax, and under side with a very dense silky flavescent pubescence; antennæ black; head and prothorax very closely and finely punctate, the punctures simple; elytra with two distinct costules on each side and covered with deep, slightly uneven punctures of equal size on the yellow parts, and more rugose and slightly shagreened on the black intervals; the pale yellow colour of the transverse bands has invaded the greatest part of the black background which is thus reduced to a sub-arcuate scutellary patch, a humeral spot and three very narrow, transverse, zigzagged bands reaching from side to side, the posterior one emitting a supra-outer marginal ramus ending in a small round patch situated at about the central part of the supra-apical part.

Length 14 mm. ; width 5½ mm.

This species seems to occur along the West Coast of Africa, from Senegambia to Damaraland. My examples are from Okahandja in Damaraland.

MYLABRIS BASIBICINCTA, Mars.,
Plate XXIV., fig. 65.
Monogr., p. 497, pl. v., fig. 53.

? *lacerata*, Péring., Trans. South Afric. Philos. Soc., iv., 1888, p. 130, pl. 3, fig. 11.

Intermediate in size and markings between *M. dentata* and *Ceroctis groendali*. From *dentata* it differs by the pubescence of the head, prothorax and under side, and the much more remote and deeper punctuation of the head and prothorax; the black background of the elytra is much more rugose, the yellow bands are also more broadly separated; they bear on each side a broad, basal pale yellow band reaching from the suture to the outer margin and the lower edge of which is bi-denticulate; this band includes a small humeral black spot; the ante-median band is not quite as broad as the basal, and is strongly bi-incised on each border; the post-median one seems to consist of two coalesced patches, the broader of the two being adjacent to the suture, and the borders are thus deeply bi-incised; the apical band, which does not quite reach the suture and the outer margin, consists of two patches the outer of which is the smaller of the two, and is occasionally narrowly connected with the larger.

Length 10–10½ mm. ; width 4 mm.

Hab. Cape Colony (Kenhardt, Beaufort West).

My *M. lacerata* seems to differ very little from the typical *M. basibicincta*, except that the apical yellow band is divided into two. I have however identified Marseul's type from the description and figure only, and M. Lesne informs me that my *M. lacerata* is not represented in Marseul's collection.

South African Species which I have not seen, or been able to identify.

A². Antennæ black.

MYLABRIS TRIFOLIA, Mars.,
Plate XXIII., fig. 60.
Monogr., p. 461, pl. v., fig. 39.

"Oblong, moderately wide and moderately convex, black, shiny, sparsely hairy, hairs black; head sub-quadrate, strongly inflated behind the sinuate, globose eyes, and densely punctate, frontal part moderately convex and slightly impressed on each side; antennæ slender; prothorax broad, vaguely punctate, the sides roundly dilated, coarctate and suddenly narrowed in front, reflexed at the base, sub-impressed in the centre; scutellum strigulose, rounded at apex; elytra vaguely punctulate, subparallel, marginate, the shoulders raised, rounded at apex, and having on each side an ante-median, narrow, sinuate, pale yellow transverse band, a basal outer marginal ovate macule, and close to the base another median macule; the posterior band is broader and dilated in the centre of the posterior border into a very distinct patch; this posterior band is blood-red.

Length 20 mm.; width 7 mm.

Hab. Kaffraria."

Marseul places this species after *M. lavateræ*.

MYLABRIS SVAKOPINA, Mars.,
Plate XXIV., fig. 66.
Monogr., p. 477, pl. v., fig. 46.

Oblong, sub-cylindrical, black, opaque above, hardly pubescent; head and prothorax deeply punctate; antennæ strongly clavate; elytra subparallel, closely rugose punctate, and having on each side a dorsal sub-basal yellow patch connected near the scutellary region and along the suture with a moderately broad transverse ante-median band, and an outer marginal narrower band reaching from the base to the said

transverse band; past the middle is a narrower band interrupted in the centre and disconnected from the suture; this band is probably occasionally entire.

Length 10 mm.

Hab. Damaraland (Svakop River).

Marseul states that this species cannot be mistaken for any other.

A'. Antennæ yellow with the two basal joints black.

MYLABRIS GAMICOLA, Mars.,
Plate XXIII., fig. 56.
Monogr., p. 436, pl. iv., fig. 23.

Elongated, sub-cylindrical, black, densely punctulate, clothed with a thick, silky yellow pubescence; antennæ long, very slender; prothorax sub-quadrate, rounded laterally, little narrowed in front, finely canaliculate in the centre; elytra with a basal dorsal elongate pale yellow band reaching to about one-third of the length and somewhat triangular at apex, at about the middle is a transverse strongly bi-sinuate band of the same colour and broadly disconnected from the suture, and in the posterior part a similar but narrower band; both these bands are connected along the outer margin by a broad band of similar colour running from the base.

Length 14 mm.

Hab. N'Gamiland.

MYLABRIS BICINCTA, Mars.,
Plate XXIII., fig. 49.
Monogr., p. 521, pl. v., fig. 60.

Elongated, moderately convex, black, clothed with a silky silvery pubescence; head and prothorax densely punctate; antennæ moderately slender; prothorax broad, little convex, deeply impressed transversely past the anterior border; elytra densely rugosely punctulate and having on each side a slightly slanting dorsal basal band connected along the base with a humeral band running along the outer margin and connected there with an ante-median transverse somewhat narrow band reaching the suture, and very slightly sinuate; past the middle is a similar but narrower band, and a somewhat broader quite apical one; these bands are orange-yellow and densely punctate.

Length 13 mm.; width $4\frac{1}{2}$ mm.

Hab. N'Gamiland.

MYLABRIS NATIVA, Voigts.,
Deutsch. Ent. Zeitsch., 1903, p. 107.

"Oblong, black, opaque; antennæ yellow with the two basal joints black, 3rd and 4th of equal size; palpi black; flavo maculate underneath; mentum flavescent at apex; head and prothorax coarsely and densely punctate, the punctures denser towards the middle and the sides of the former, both are clothed with black hairs, the head has a smooth space between the eyes and often a longitudinal more or less raised line; the prothorax is as broad as long, with the sides rounded, and is narrower in front, the dorsal part is transversely impressed in the centre and before the base and has in addition some more or less distinct, irregular impressions, from the base to the apex is a longitudinal smooth more or less raised line and a median impression slightly sulcate; elytra deeply and densely rugulose punctate, clothed with black villose hairs in the basal region, and with black, depressed hairs mixed with greyish ones on the rest of the surface, these have each four longitudinal raised lines; on each side are two small rounded flavous sub-equal basal macules, one dorsal, the other humeral, and situated between the gibbosity and the lateral margin, two transverse fasciæ, the one situated before the median part, broader towards the suture than towards the margin with the anterior border nearly straight, sub-undulate on the posterior, slightly oblique from the suture outwardly, the second situated past the middle, is nearly twice broader towards the suture than outwardly, moderately abruptly narrowed outwardly towards the second raised line, and undulate behind, these fasciæ are yellow, moderately shiny, nearly glabrous, more finely and more sparsely punctate with the punctures brownish, the posterior fascia is girded in front, and much more so behind with red with a vague tinge of black; under side punctulate, clothed with a black villosity; anterior femora and tibiæ with the inner part pilose, the hairs golden fulvous; posterior tarsi with the first joint red at the base; spurs of the hind tibiæ equal, red, flavous at apex.

Length 33 mm.

Hab. Natal."

This species would seem to approximate the large examples of *M. oculata*, var. *vulgaris*.

GEN. CEROCTIS, Mars.,
Plate XXIV., fig. 67.
Monogr. Abeille, vol. vii., 1870, p. 9.

The genus differs from *Mylabris* in the shape of the antennal joints which are strongly serrate inwardly, and even flabellate in the ♂. All the species are African.

A². Elytra with transverse bands and spots.

B³. Antennæ black.

C². Elytra with a dorsal and a lateral patch, both occasionally coalescent, and two transverse yellow or red bands, sometimes interrupted, no apical patch.

D⁶. Basal and lateral patches always broadly separated from the anterior band, basal dorsal patch strongly lunulate.

Dorsal patch produced into a longitudinal lunule, the two bands broadly interrupted and reduced to two yellow patches connected with the suture, and two smaller, sub-triangular, outer marginal. Elytra strongly shagreened (pl. xxiv., fig. 68) .. .. *capensis*

D⁵. Basal and lateral patches not always broadly separated from the anterior band; basal dorsal patch not lunulate.

The dorsal and lateral patches have invaded the whole base, forming a broad band coalescing with the anterior except for two non-obliterated triangular spots of the background; posterior moderately wide, anterior edge emarginate in the centre, posterior dentate there (pl. xxiv., fig. 69) .. .. *korana.*

The basal, dorsal, and lateral patches coalesce so as to form a basal band separated from the anterior transverse one (pl. xxiv., figs. 70, 71) .. .. *koranella.*

The basal dorsal and lateral patches are quite separated, and so are the anterior and posterior bands, which are each divided into two patches (pl. xxiv., fig. 72) .. .. *karroensis.*

C¹. Elytra with a dorsal and a lateral patch, two transverse yellow or reddish bands either coalescing, often interrupted or pinched in the centre, and an apical patch or band.

D⁴. Basal, dorsal, and lateral patches and bands coalescing into a very broad band reaching past the median part.

Basal, dorsal, and lateral patches uniting with the anterior band, which in turn unites with the post median; a broad, sub-hamate red patch in the posterior part and a small black spot on the dorsal part at some distance from the base (pl. xxiv., fig. 73) .. .. *gariepina.*

D³. Basal patch and lateral spot not invading the whole of the base.

Dorsal patch of elytra coalescing at the suture and connected alongside of it with the anterior narrow yellow band which is constricted in the centre, and is connected along the outer margin with the lateral basal

patch; posterior band strongly bi-constricted, much narrower near the margin than near the suture, continued as a red band along the outer margin and coalescing at apex with a very broad, dark-red patch (pl. xxiv., fig. 74) .. .. *péringueyi.*

D². Basal patch of elytra not connected in the dorsal part with the anterior band.

A dorsal basal elongate red patch and a lateral one connected along the suture with a median, very little sinuate red band, post-median band similar in shape and colour, posterior patch filling the apex, and also red; pubescence flavescent (pl. xxiv., fig. 76) .. .. *blanda.*

Dorsal yellow or sub-orange-yellow basal patches ovate, reaching the suture; anterior and posterior bands strongly constricted in the centre, triangularly dilated towards the outer margin, but occasionally divided each into two patches, apical part invading nearly the whole apex, or crescent-shaped; body shagreened (pl. xxiv., figs. 77, 78) .. .. *gyllenhali.*

The same, but with the dorsal basal patches coalescing across the suture, apical patch reaching very short of the suture; body not shagreened (pl. xxiv., fig. 79) .. *serricornis.*

Base of elytra with a basal, yellowish, or yellowish red transverse band nearly equal in width to the anterior and posterior which are narrow, strongly bi-zigzagged, and expand narrowly along the outer margin; apical patch sub-transversely ovate, median but emitting a spur towards the outer margin (pl. xxiv., fig. 80) .. *spuria.*

Each elytron with four yellow, more or less rounded patches between the dorsal part and the suture, a humeral elongated yellow band connected with a sub-median lateral patch, past the middle another marginal patch; these two marginal patches are occasionally connected with the two dorsal ones, or very narrow and broadly disconnected (pl. xxiv., figs. 81, 82, 83) .. *aliena.*

Elytra each with four yellow dorsal spots set in a longitudinal row, and three marginal ones the basal of which is plainly elongated (pl. xxiv., fig. 84) .. .. *bohemani.*

D¹. Basal part of elytra with a broad yellow band connected more or less completely with the anterior one.

B². Antennæ reddish or yellow with the two basal joints black.

Dorsal patch of elytra coalescing along the suture with the anterior moderately bi-sinuate band, second band constricted in the centre, reduced thence to the margin by half its width, and with the lower edge bi-sinuate; apical part with two ovate, coalescing patches; bands and patches reddish; antennæ flabellate inwardly (pl. xxiv., fig. 75) .. .. *marshalli.*

B'. Antennæ black with joints 3–6 flavescent.

Surface of elytra pale yellow but occasionally also orange-yellow; on each side are a supra-humeral black spot, three ante-median ones disposed transversely, two strongly sinuate dentate somewhat narrow black bands; the apical angle is also black (pl. xxiv., fig. 85) .. .. *groendali.*

The same, but the humeral black spot and the three anterior ones are reduced to a mere dot; the posterior band is interrupted in the centre (pl. xxiv., fig. 86).. .. .. var. *extrema.*

Basal part yellow for about one-third of the whole length, and with a humeral small patch and a juxta-sutural spot of the black background showing through; the post-median band is plainly sinuate, the apical one is transverse, and both are red (pl. xxiv., fig. 87) .. .. *quadrifasciata.*

A'. Elytra with longitudinal bands and spots.

Elytra each with a longitudinal dorsal and a lateral yellow or orange-yellow band reaching from the base to past the middle, and two or three patches in the posterior part; upper side with a dense, very short silky pubescence:

Dorsal band reaching slightly past the middle, three distinct, round patches; tibiæ black (pl. xxiv., fig. 88) .. .. *trifurca.*

Dorsal band reaching to four-fifths of the length, a posterior marginal transverse patch and a supra-apical one; tibiæ black (pl. xxiv., fig. 89) .. .. *exclamationis.*

Dorsal band reaching the supra-apical patch, or not; the posterior marginal patch small, slightly transverse; femora and tibiæ flavous (pl. xxiv., fig. 90) .. .. *phalerata.*

CEROCTIS CAPENSIS, Linn.,
Plate XXIV., fig. 68.

Mus. Lud. Ulr., 1764, p. 104; Billb., Monogr., p. 37, pl. 4, fig. 11; Oliv., Entom., iii., 47, 12,'2, pl. 2, fig. 12; Mars., Monogr., p. 553, pl. v., fig. 66.

Black, clothed on the under side, head and prothorax with a dense, erect, black pubescence; antennæ black, the five apical joints with a somewhat silky sheen, inner part of the intermediate joints moderately sharply acuminate at the tip; head and prothorax very closely scrobiculate punctate, frontal part with a short median line, prothorax with no distinct one; elytra elongated, strongly shagreened and with the yellow patches or bands roughly and somewhat closely punctate; each bears a basal dorsal band curving outwardly into a lunule and reaching to about one-fifth of the length, and an elongated lateral band; at about the median part is a

transverse patch connected with the suture and reaching to about the median part of the disk, and a similar but slightly longer one at a short distance from the apex; on the outer margin are two short patches situated each at an equal distance from the basal lunule and the anterior patch and from the anterior and posterior ones.

The dorsal part of the abdomen is pinkish red, and shows conspicuously when the insect flies, but in examples from the Northern Transvaal this part is black.

Length 9–14 mm.; width 3–4½ mm.

Hab. Cape Colony (Cape Town, Stellenbosch, Paarl, Ceres, Worcester, Malmesbury, Namaqualand, Kimberley, Mossel Bay, Knysna, Grahamstown, East London, Somerset West).

This species is generally found singly or in pairs, and its pattern very seldom varies. No varietal form has come to my notice.

CEROCTIS KORANA, Péring.,

Plate XXIV., fig. 69.

Trans. S. Afric. Phil. Soc., iv., 1888, p. 130, pl. iii., fig. 9.

Black, clothed with a very short black pubescence, not very dense on the head and prothorax which are deeply but somewhat sparsely punctate, the punctures on the former are however closer on the epistome, and the frontal, smooth patch is plain; on the elytra the pale yellow parts are deeply and moderately closely scrobiculate punctate, but the much-reduced black background is very deeply and closely punctulate; the anterior part from the base to slightly past the middle is pale yellow with the exception of a triangular black patch situated at about one-fourth of the length, and the edge of this yellow part is slightly bi-sinuate; at an equal distance from the anterior yellow band and from the apex is a moderately broad band extending like the anterior one from side to side, and slightly scooped in the anterior border, the posterior is arcuate.

Length 12 mm.; width 4 mm.

Hab. Cape Colony (Kenhardt).

Var. KORANELLA,

Plate XXIV., figs. 70, 71.

Like the type in sculpture and vestiture, but on the elytra is a broad basal pale yellow patch which coalesces with the lateral (fig. 71) and even forms with it a broad transverse basal band (fig. 70); there is an ante-median transverse band reaching from side to side with both the

edges sharply sinuate, and the post-median one is of the same size as the ante-median, and similarly scooped in the anterior edge.

Length 9–12½ mm.; width 4–5 mm.

Hab. Cape Colony (Prieska).

Ceroctis karroensis, n. sp.,
Plate XXIV., fig. 72.

Black, moderately shiny, clothed on the head and prothorax with a moderately dense, appressed greyish flavescent pubescence which is very short on the elytra, but a little longer there in the posterior than in the anterior part; antennæ black, very sharply serrate; head and prothorax covered with unequal rugose, contiguous foveate punctures; head with a conspicuous median raised line; elytra closely shagreened and having on each side a row of three dorsal yellow patches equi-distant from the suture and the median dorsal part and three corresponding ones on the outer margin. It is probable that both the second and third dorsal and marginal patches do occasionally meet, as they are somewhat sinuose, whereas the first basal dorsal patch is quite round. Under side and legs moderately pubescent.

This species, of which I have seen only one example (♂), is allied to *M. koranella*, but the 5–7 joints (♂) are not so sharply serrate inwardly, and the two transverse bands of the elytra, if they united, would be much narrower than in *M. koranella.*

Length 9 mm.; width 3 mm.

Hab. Cape Colony (Beaufort West).

Ceroctis gariepina, Péring.,
Plate XXIV., fig. 72.
Trans. S. Afric. Philos. Soc., iv., 1888, p. 130, pl. iii., fig. 10.

Black; antennæ black; head, prothorax, and under side clothed with a short, dense, greyish flavescent pubescence; prothorax closely and somewhat roughly shagreened; elytra moderately shagreened, but with the black background more coarsely punctate than the coloured part; on each elytron there extends a pale yellow very broad band reaching to past the median part from near the base, along which is a narrow border of the black background which descends also laterally below the humeral part; this yellow band encloses a small black dot situated at about one-quarter of the length, and is deeply scooped twice on the hind margin which is separated only by a narrow interval from a reddish elongated patch extending from close along the suture to about one-third of the width without reaching the apex, strongly constricted at about the

median part and produced thence right to the outer margin into a much narrower transverse band.

This species, of which I saw only two partly mutilated examples, would seem to be very distinct from *C. korana*, although found in the same locality.

Length 12 mm.; width 5 mm.

Hab. Cape Colony (Prieska).

CEROCTIS PÉRINGUEYI, Vogt.,
Plate XXIV., fig. 74.
Wien. Ent. Zeit., xx., 1901, p. 215.

C. distincta, Péring., Trans. S. Afric. Phil. Soc., iv., 1888, p. 131, pl. 3 (name preocc.).

Black, clothed with a short, black pubescence turning to sub-flavescent on the prothorax; antennæ black; head and prothorax covered with sub-contiguous, somewhat deep, round punctures; elytra with the yellow part closely and evenly punctulate, the black part shagreened aciculate, the red part more roughly punctate than the yellow; on each side the broad basal dorsal patch is connected along the suture with the anterior transverse band which is narrow, slightly scooped in the anterior edge, and expands along the outer margin where it becomes one with the lateral dorsal patch, thus forming a marginal band; the posterior band is greatly constricted in the median part and narrowed thence to the outer margin where it is continued as a red band coalescing with the posterior part, which is wholly blood-red except for a narrow, apical black border.

Length 11 mm.; width 4 mm.

Hab. Cape Colony (Kenhardt).

CEROCTIS MARSHALLI, Pic.,
Plate XXIV., fig. 75.
Rev. d'Entomol., xxii., 1903, p. 165.

C. mosambica, Pér., Ann. S. Afric. Mus., iii., 1904, p. 283.

Black, clothed with a flavescent pubescence with admixed fuscous hairs on the head and prothorax; antennæ rufous flavous with the two basal joints black, the intermediate joints from the sixth to the seventh are so sharply acuminate inwardly at apex as to be almost sub-flabellate; head and prothorax covered with deep, but small, nearly contiguous punctures, in the former there is no visible frontal patch, in the latter the central, discoidal impression reaches from the centre to the base; elytra elongated, the orange-red dorsal bands are very closely punctate, and the punctures on the black background are as closely punctate but slightly

more shagreened; on each side the basal dorsal ovate patch coalesces along the suture with the broad anterior band which is moderately deeply sinuate, the lateral patch is elongated but does not reach the anterior band, the post-median is broad and sub-quadrate from the suture to the median part, narrowed thence to the outer margin by about one-third, and the hind border is narrowly but somewhat deeply incised at about the middle; close to the apex but reaching neither the margin nor the suture are two elongate ovate patches coalescing at about their median respective part.

Length 24 mm.; width 8 mm.

Hab. Southern Rhodesia (Salisbury); Mozambique (Rikatla, Maputa River).

This species is easily recognised from among the other South African *Ceroctis* by its sub-flabellate antennæ.

CEROCTIS BLANDA, Pér.,
Plate XXIV., fig. 76.
Trans. S. Afric. Phil. Soc., vi., 1892, p. 64.

Black, clothed with a dense flavescent, sub-silky pubescence very noticeable on the elytra; antennæ black, the intermediate joints strongly aculeate flabellate in the inner side in the male, serrate only in the female; head and prothorax covered with deep punctures separated by a narrow, somewhat irregularly raised wall, and coalescing in some places, especially on the frontal part; black background of elytra finely shagreened, the bands and patches are red and covered with deep, contiguous, moderately small punctures, the basal dorsal patch is more in the shape of a longitudinal band reaching to one-fifth of the length, there is a lateral somewhat narrow band which rounds the shoulder, coalesces narrowly there with the dorsal band, and is produced downwards along the margin as far as the anterior transverse band which is of moderate width and only slightly bi-sinuate on each border, the post-median band is of the same width as the anterior, and the hind border is also slightly bi-sinuate, the posterior patch fills the whole apical part.

Length 10–10½ mm.; width 4 mm.

Hab. Ovampoland.

CEROCTIS GYLLENHALI, Billb.,
Plate XXIV., figs. 77, 78.
Monogr., p. 21, pl. 2, figs. 17, 18; Mars., Monogr., p. 550, pl. v., fig. 64.
variabilis, Oliv., Entom., iii., 47, p. 10, pl. 2, fig. 14*a*.

Black, clothed on the under side, head and prothorax with a dense, black, erect pubescence, antennæ totally black, the intermediate joints

strongly acuminate inwardly; head and prothorax covered with deep, but small, uneven, rugose, contiguous punctures; elytra elongated, parallel, very scabrose on the black background, less so on the yellow, or orange-yellow patches or bands, owing to the punctures, which although scabrose, are less closely set, on each side are (type) a basal, dorsal, round, moderately large or large patch and a lateral, elongated one, two in the anterior part, two in the post-median, the lateral being smaller than the juxta-sutural, which does not reach quite the suture, and one apical (pl. iii., fig. 77); this typical form is however the rarest; in most examples the two ante-median and post-median patches coalesce near the middle of the disk and form thus two continuous bands strangulated in the centre (pl. iii., fig. 78), or these two bands are completely united and their anterior edges are bi- and the posterior edges tri-dentate, the apical patch is arcuate as if it consisted of two coalesced patches.

It is not uncommon to meet with examples in which the posterior band and patch are red; occasionally all the patches are red or deep orange-red.

Length 11–17 mm.; width $3\frac{3}{4}$–6 mm.

Hab. Cape Colony (Cape Town, Stellenbosch, Paarl, Worcester).

CEROCTIS SERRICORNIS, Gerst.,
Plate XXIV., fig. 79.

Monatsb. Berl. Acad., 1854, p. 694; Peter's Reis. n. Mos., 1862, p. 300, pl. 18, fig. 1; Mars., Monogr., p. 548, pl. 5, fig. 63.

This species is so closely allied in general appearance and markings of the elytra to *C. gyllenhali* (large development) that it might easily be mistaken for it; but it differs in the following points: the pectination of the antennal joints is not so long; the claws are black or fuscous instead of being yellow; the head and prothorax are slightly roughly punctate but not shagreened, and the sculpture of the elytra consists of round, simple, moderately deep punctures, instead of a scabrose surface; the basal and lateral round yellow patches are similar in both species, but the anterior band is only slightly constricted in the centre, the post-median one is plainly separated, forming thus two sub-transverse patches separated by a narrow line, the apical patch is transversely elongate ovate.

In the type, *apud* Gerst., the dorsal round patch is elongated near the suture towards the anterior band, and the lateral is continued as a marginal band uniting there the two transverse bands.

Length 18 mm.; width 6 mm.

Hab. Mozambique (Rikatla).

CEROCTIS SPURIA, Fåhr.,
Plate XXIV., fig. 80.

Öfv. Vet. Ak. Forhdl., 1870, p. 344; Mars., Monogr., p. 500, pl. v., fig. 55.

C. vexator, Péring., Ann. S. Afric. Mus., iii., 1904, p. 284.

Black, clothed with a short, appressed flavescent pubescence on the under and upper sides; antennæ black; head and prothorax very deeply sub-scrobiculate punctate, frontal line distinct or not; elytra without any traces of costules, very closely punctate shagreened, the patches and bands are yellow with a more or less pronounced orange-yellow tinge, on each side are three transverse bands, a basal with a bi-sinuate hind border, an ante-median deeply bi-sinuate in the anterior border and tri-sinuate in the posterior, a post-median one tri-denticulate on each border, and a supra-apical patch emitting a short spur towards the outer margin, all the three bands are continued downwards for a short distance along the outer margin, and the basal band is even connected there with the ante-median band. Fåhrœus mentions a variety in which the basal band does not quite reach the humeral part, and another where this basal band is dilated inwardly, and becomes connected with the intermediate band towards the sutural part. This goes to show that the disposition of the bands is very variable.

Length 11 mm.; width 4½ mm.

Hab. Transvaal (Pietersburg).

CEROCTIS ALIENA, Pér.,
Plate XXIV., figs. 81, 82, 83.
Trans. S. Afric. Philos. Soc., vi., 1892, p. 64.

Black, clothed on the head and prothorax and on the under side with a dense flavescent silky pubescence; antennæ black; head and prothorax covered with rugose, nearly confluent punctures, the median sulcus of the latter part is very well marked; elytra sub-foveate shagreened in the anterior part, more distinctly and more closely shagreened in the posterior, and having on each side, but only in the large development, two somewhat distinct longitudinal costules in the anterior part only; on each elytron are four equi-distant, more or less quadrate, or rounded pale yellow or orange yellow patches disposed lengthways between the median dorsal part and the suture, and disconnected from the latter; along the outer margin is an elongated band running from the humeral part and dilated triangularly opposite the second dorsal patch, where it ends; lower down, opposite to the third dorsal one, is another patch absolutely similar in shape (fig. 81); in the first varietal form (fig. 82) the basal patch nearly coalesces with the

lateral band, the triangular point of which unites also with the second juxta-sutural spot forming thus a somewhat zigzagged band, the two post-median spots are no longer rounded, and they approximate closely to each other; in fig. 83, which is really the type, the four dorsal patches are rather jagged and broadly separated from the much-reduced lateral band and spot.

Length 9–14 mm.; width 4–6 mm.

Hab. Transvaal (Pietersburg), Damaraland (Walfish Bay), Ovampoland.

Ceroctis bohemani, Fåhr.,
Plate XXIV., fig. 84.

Öfv. Vet. Ak. Forhdl., 1870, p. 345; Mars., Monogr., p. 558, pl. 5, fig. 69.

Black, clothed with a short, appressed greyish white silky pubescence; antennæ black, joints strongly serrate inwardly, femora rufescent from the base to three-fourths of the length; head and prothorax very closely punctate, the punctures fine and round, but wider and more scattered on the frontal part; elytra finely shagreened and with the two dorsal lines well marked, on each side are four superposed juxta-sutural bright yellow, more or less ovate patches, a lateral longitudinal short band at the shoulder, and two small patches on the outer margin, the one anterior, the other post-median.

Length 13 mm.; width 5 mm.

Hab. Transvaal (Pietersburg, Waterburg, Rustenburg, Pretoria, Klerksdorp), Natal (Eshowe), Southern Rhodesia (Bulawayo, Victoria Falls, Salisbury).

Ceroctis groendali, Billb.,
Plate XXIV., fig. 85.

Monogr., p. 30, pl. iii., figs. 17, 18; Mars., Monogr., p. 556, pl. 5, fig. 68.

Black, covered with a long, black and greyish, and very dense pubescence on the under side, the head and prothorax; antennæ black, the intermediate joints serrate; head and prothorax very closely and somewhat roughly punctured, frontal smooth mark distinct; elytra covered with deep, sub-contiguous punctures divided by a raised wall imparting to them a coriaceous shagreened appearance; the pale yellow bands have invaded the greatest part of the surface, and the black background is thus reduced to a small humeral spot, three more disposed transversely in the anterior part, a median and a posterior strongly zigzagged narrow band, the latter expanding towards the outer margin which neither band reaches, and a small sutural apical dot.

Length 10–12 mm.; width $4\frac{1}{2}$–5 mm.

Hab. Cape Colony (Port Elizabeth, Grahamstown, East London), the whole of Orange River Colony, Natal, and the Transvaal.

Var. EXTREMA,

Plate XXIV., fig. 86.

Same as the type, but the humeral and the three anterior black spots are reduced to a mere dot, the median and posterior bands reach the suture, and the posterior is occasionally interrupted in the centre.

Length 12–16 mm.; width 5–$5\frac{1}{2}$ mm.

Hab. The eastern and northern part of the Cape Colony; the whole of Orange River Colony, Natal, Transvaal.

CEROCTIS QUADRIFASCIATA, Thunb.,

Plate XXIV., fig. 87.

Dissert. Nov. Insect. Spec., vi., p. 115, fig. 18; Billb., Monogr., p. 19, pl. ii., figs. 4–8.

bipunctata, Billb., *loc. cit.*, p. 31, pl. 4, fig. 1; Mars., Monogr., p. 551, pl. v., fig. 65.

Black, clothed with a dense, moderately short black pubescence; antennæ black, joints moderately sharply serrate; head and prothorax covered with small, smooth, somewhat shallow contiguous punctures, the former with a very distinct frontal line; elytra with a broad basal pale yellow band and two narrower orange-red ones, the black background is closely shagreened, the yellow and red bands scrobiculate, and the two dorsal costules are strong, the basal yellow band extends from the base to two-fifths of the length, and encloses a small dorsal black spot and a sub-humeral, small black patch, the hind border of this band is slightly scooped laterally, the second band is less than half the width of the anterior, and uni-sinuate on each border, the posterior is supra-apical, somewhat narrower than the second, and reaches from suture to margin.

Length 14–15 mm.; width $5\frac{1}{4}$ mm.

Hab. Cape Colony (Namaqualand).

The figures given by Billberg (*loc. cit. supra*) do not agree with this species, but with varieties of *C. gyllenhali*, with which, however, *C. quadrifasciata* is so closely allied that it might be considered as a variety only were it not for its restricted habitat and its constant pattern.

CEROCTIS TRIFURCA, Gerst.,
Plate XXIV., fig. 88.
Monatsb. Berl. Acad., 1854, p. 694; Peter's Reis., 1862, p. 298; Mars., Monogr., p. 204, pl. v., fig. 74.

ruficrus, Gerst., *loc. cit.*, p. 695; Peter's Reis., p. 301.

Elongated, parallel, black, covered with a fine, appressed sub-flavescent silky pubescence; antennæ black, intermediate joints almost flabellate: head and prothorax very closely punctate, the punctures slightly rugose; elytra aciculate shagreened, the yellow bands and spots deeply punctate, each one with a flavous narrow dorsal longitudinal band reaching from the base to the median part, or slightly past that point; at about an equal distance from the end of that band and the apex is a round patch, and another at the apex itself, along the outer margin runs a similar band beginning at the basal part of the shoulder and reaching the middle, and at a short distance from it a small patch set opposite to the post-median dorsal one and a little less rounded than the latter; legs black, but occasionally flavescent (*ruficrus*).

Length $10\frac{1}{2}$ mm.; width 4 mm.

Hab. Mozambique (Beira), Southern Rhodesia (Plumtree). Occurs also in German East Africa.

In two examples of *C. trifurca*, kindly sent me by Professor H. Kolbe, compared to the type, the longitudinal dorsal band coalesces with the post-median dorsal round spot.

CEROCTIS EXCLAMATIONIS, Mars.,
Plate XXIV., fig. 89.
Monogr., p. 563, pl. v., fig. 72.

Var. *bi-vittata*, Mars., Monogr., p. 560, pl. v., fig. 71.

Similar to *M. trifurca*, Gerst., the sculpture and the vestiture are the same, but the elytral dorsal band reaches from the base to four-fifths of the length, the round post-median patch being completely absorbed by it, and at an equal distance from the end of the dorsal line and of the apex is an elongate ovate patch, the lateral marginal band runs from the base of the shoulder to somewhat past the median part, and at some distance from it is a transverse patch reaching from the margin to a little more than one-third of the width. The intermediate joints of the black antennæ are as strongly serrate flabellate as in *M. trifurca*, and the elytral bands and patches are more orange yellow; legs black. *C. bi-vittata* seems to be a variety in which the dorsal band coalesces narrowly with the supra-apical patch; and the lateral one is nearly as long as the dorsal.

Length 11–12 mm.; width 5 mm.

Hab. Southern Rhodesia (Salisbury).

Ceroctis phalerata, Erichs.,

Plate XXIV., fig. 90.

Wiegm. Arch., 1843, p. 256; Mars., Monogr., p. 563, pl. v., fig. 73.

Greatly resembles the two preceding species, but is distinguished by the shorter, more appressed sub-flavescent pubescence which is also not silky, and is considerably denser on the elytra; the legs, tarsi and knees excepted, are red; the colour of the bands and patches on the elytra is orange yellow, on each elytron the dorsal band reaches from the base to three-fourths of the length, and at an equal distance from the end of this band and of the apex is a sub-transverse patch, the lateral marginal band reaches to two-thirds of the length, and close to it is a short, sub-transverse marginal patch. In all my examples the dorsal band reaches nearer to the supra-apical spot than in Marseul's figure, *loc. cit.*

Length $10\frac{1}{2}$ mm.; width $4\frac{1}{2}$ mm.

Hab. Cape Colony (Prieska), Transvaal (Pretoria, Potchefstroom), Orange River Colony (Parys), Damaraland (Okahandja), Ovampoland.

Gen. MIMESTHES, Mars.,

Plate XXIV., fig. 133.

Monogr., 1872, p. 207.

The only species included in this genus differs from *Mylabris*, *Ceroctis*, *Decatoma*, *Coryna*, &c., by the depressed form of the elytra which are sub-transversely truncate behind and with the inner angle not rounded; the prothorax is more transverse, and very little attenuated in front; the basal joint of all the tarsi is very long, even in the anterior legs where it is as long as the two following taken together. The antennæ are 11-jointed, but the club consists of three joints so closely set, although the sutures are quite distinct, as to resemble nearly that of the genus *Coryna*.

Mimesthes maculicollis, Mars.,

Plate XXIV., figs. 134, 135, 136.

Monogr., p. 207, pl. ii., fig. 76.

Black, covered with a moderately dense, fairly long greyish black pubescence, antennæ black; head closely and roughly punctulate; prothorax parallel, almost as broad as long, covered with moderately deep, round punctures which are scattered in the anterior part, and are more closely set in the posterior; they have on each side of the anterior part a rufescent yellow patch separated from each other by a narrow discoidal band; elytra parallel, depressed, very briefly pubescent, finely shagreened on the black background, very closely punctate on the yellow

bands and patches; on each side there is a basal macule occupying nearly the whole dorsal part, and a smaller lateral one; the anterior band is produced triangularly forward in the centre, the space of the hind border being correspondingly scooped; the post-median band somewhat resembles the anterior, but is not so sharply dentate in the anterior border, and along the apex is a transverse, elongated patch reaching neither suture nor outer margin.

Length $7\frac{1}{2}$–$13\frac{1}{2}$ mm.; width 3–$4\frac{1}{2}$ mm.

Var. *a*. The basal dorsal macule coalesces close to the suture with the dorsal part of the anterior band, leaving a small sub-median spot of the background showing.

Var. *b*. The yellowish red prothoracic band has invaded the whole anterior part, and the elytra are black with the exception of a small apical yellowish red transverse patch.

Hab. Cape Colony (Namaqualand, Carnarvon, Prieska).

Gen. DECATOMA, Cast.,

Plate XXIV., fig. 91.

Hist. Nat. d. Ins., ii., 1840, p. 268.

Antennæ ten-jointed, last joint dilated, more or less ovoid.

Key to the Species.

A[1]. Antennæ with the five basal joints black, the others yellow.

Elytra with a dorsal basal band, patch or lunule, a lateral one, and two transverse, strongly sinuate or sinuate dentate bands.

A longitudinal yellow band from the base to short of the median part, a sinuate median patch, and a rounded supra-apical one in the dorsal part, an elongated humeral and two hamate ones along the outer margin (pl. xxiv., fig. 92) .. .. *catenata*.

An ovate rounded basal dorsal patch and a lateral spot, two bands of nearly equal size, the former with both margins broadly scooped, the latter scooped in the anterior margin and with the lower sinuate (pl. xxiv., figs. 93, 94). .. .. *cafra*.

An arcuate basal dorsal patch the apex of which reaches the suture and is slightly connected there with an anterior band considerably narrowed from the middle to the suture, the hind margin of the narrowed part strongly bi-incised, posterior band similar in shape and size, but with the anterior margin also bi-incised (pl. xxiv., fig. 95) .. .. *lunata*.

Basal lunule and the two transverse bands plainly separated, the two bands narrow, each bi-sinuate dentate on both edges (pl. xxiv., fig. 96) .. .. var. *omega*.

Basal lunule thickened inwardly at apex, the two transverse bands broad close to the suture, very narrowed and strongly sinuate from near the median part to the outer margin (pl. xxiv., fig. 97) .. .. var. *umtalina.*

Basal lunule small, little arcuate, the two bands very broad, of equal width, coalescing along the outer margin and separated on the dorsal part by a very narrow band of the background culminating into a small patch (pl. xxiv., fig. 98) .. .. var. *disputabilis.*

Basal lunule sub-longitudinal, thickened on the posterior part and reaching one-third of the length, anterior band acuminate behind and reaching the second one; both the bands are narrowed laterally and the edges deeply sinuate dentate (pl. xxiv., fig. 99) .. .. .. var. *salisburiana.*

Basal lunule coalescing in the centre of the disk with the anterior band which is separated from the posterior by a moderately wide space; shape of the bands as on the previous variety (pl. xxiv., fig. 100) .. .. var. *digressa.*

Elytra suffused with yellow from the base to the median part except for a square, small black patch on the scutellary region, hind margin dentate along the suture, bi-sinuate laterally, hind band strongly bi-sinuate, narrow, and tapering towards the outer margin (pl. xxiv., fig. 101) .. .. var. *rhodesiana.*

The same, but at about one-third of the length there is a small median black dot, and the posterior band similar in shape to that of *rhodesiana* is broader and connected by a narrow line with the sub-median part of long anterior yellow patch (pl. xxiv., fig. 102) var. *lydenburgia.*

Basal lunule slanting, not crescent-shape; anterior band very narrow, of nearly equal width, narrowly interrupted above the outer margin, posterior band very slender, interrupted past the median part (pl. xxiv., fig. 103) .. .. var. *johannis.*

Basal part of elytra with a long, yellow lunule, two narrow bi-sinuose yellow bands, the posterior slightly wider than the anterior (pl. xxiv., fig. 104) .. .. *sobrina.*

A^2. Antennæ black, with the joints 3–6 flavescent.

Surface of elytra pale yellow, on each side two rows of three black spots disposed diagonally, a supra-apical series of two spots, and the edge of the apical part black (pl. xxiv., fig. 105) .. .. .. *transvaalica.*

Basal joint of elytra with a yellow dorsal arcuate patch reaching the suture, the two bands very narrow, both sinuate dentate, the posterior more strongly than the anterior (pl. xxiv., fig. 106) .. *undata.*

Basal lunule invading the median anterior part and coalescing there with the median band leaving only two small black spots; posterior band narrow, with both edges strongly bi-sinuate (pl. xxiv., fig. 107) .. .. *stellenboschiana.*

Anterior and posterior bands with both edges sharply tri-sinuate (pl. xxiv., fig. 108) .. .. *contorta.*

Basal lunule coalescing with the anterior band which is broadly united also with the posterior along the suture, and narrowly along the outer margin, or with the basal dorsal patch and the two bands free but dentate and coalescing along the margin (pl. xxiv., figs. 109, 110) .. .. *africana.*

Basal patch slanting towards the suture, not connected with the anterior band which is broadly scooped in the fore border, the hind one being strongly tri-dentate, posterior band also scooped in front, the hind border produced in the centre in a rounded lobe beyond the edge of the band (pl. xxiv., fig. 111) .. .. *insolita.*

Basal patch round, not coalescing with the anterior band, both edges of which are sinuate, posterior band slightly broader than the anterior with the fore border deeply scooped in the centre, posterior border bi-incised (pl. xxiv., fig. 112) .. .. *quadriguttata.*

Basal patch sub-ovate, anterior and posterior bands so broadly interrupted in the centre as to resemble four yellow patches (pl. xxiv., fig. 113) .. .. var. *minuta.*

All the yellow patches reduced to a mere dot (pl. xxiv., fig. 114) .. var. *namaqua.*

Elytra each with a basal dorsal and a lateral patch or spot, two sinuate transverse bands and an apical patch.

A[3]. Antennæ yellow, with the two basal joints black.

Basal dorsal and lateral patches broad, rounded, the two bands broad, hind margin of the anterior, and both edges of the post median plainly bi-sinuate, apical patch ovate, red, the other patches and bands yellow (pl. xxiv., fig. 115) .. .. *adamantina.*

A[4]. Antennæ black.

Basal dorsal patch comma-shape or sub-quadrate, the two transverse bands strongly zigzagged, posterior band slanting, sinuate dentate, occasionally united with the apical patch by a narrow spur (pl. xxiv., figs. 116, 117) .. .. *histrio.*

Decatoma catenata, Gerst.,
Plate XXIV., fig. 92.

Monatsb. Berl. Akad., 1854, p. 695; Peter's Reis., p. 302, pl. xviii., fig. 3; Mars., Monogr., p. 58, pl. vi., fig. 13.

Black, clothed with a dense flavescent silky pubescence; the five basal antennal joints are black, the other five rufescent flavous; the bands and patches on the elytra are moderately pale yellow; head and prothorax covered with very closely set, well-nigh contiguous, slightly rugose punctures, frontal part with a central line and smooth patch; elytra parallel, the black background and also the patches and bands covered with deep, sub-contiguous, slightly uneven punctures the intervals of which are too regularly raised to give the elytra the appearance of being shagreened, on

each side there is a basal dorsal band gradually slanting towards the suture and reaching to a third of the length, an elongated lateral one, and a sinuate median patch reaching from the suture to the median dorsal part; above this patch is a somewhat elongated, more or less triangular, or hamate marginal one the inner point of which does probably coalesce with the outer part of the median dorsal in some examples; in the posterior part and under the median patch is a sub-transverse rounded one, and a lateral broader than the one above it, also hamate, very nearly connected with the discoidal, and prolonged as a narrow band along the outer margin.

Length 14–17 mm.; width $5\frac{1}{2}$–$6\frac{1}{4}$ mm.

Hab. Southern Rhodesia (Victoria Falls); Mozambique (Beira).

Decatoma cafra, Mars.,
Plate XXIV., fig. 93.
Monogr., p. 587, pl. 6, fig. 12.

africana, Billb., Monogr., p. 57, pl. 6, fig. 8.

Black, covered with a black and greyish pubescence, dense underneath and on the head and prothorax, moderately so on the elytra, near the apex of which is a silky, whitish flavescent patch, the five basal antennal joints black, the other five yellowish rufescent; head and prothorax covered with almost contiguous, sub-rugose punctures, frontal part with a more or less distinct smooth patch; elytra plainly shagreened, bands and patches pale yellow, on each side are a sub-elongate ovate basal dorsal patch and a shorter elongate lateral one, a transverse moderately broad band consisting of two patches united in the centre of the disk by a band narrower than the patches by one-half, and a post-median band formed in the same manner, and having thus the appearance of being deeply scooped in the anterior and posterior borders.

Var. derepta.

The elytra bear each three superposed patches set between the suture and the median dorsal part, and three other, of nearly the same size, set along the suture opposite the dorsal three. The difference in the shape of the markings is simply due to the obliteration of the two transverse spurs connecting the dorsal patches as in the type form.* This variety is from Clanwilliam, Cape Colony.

Length 11–$12\frac{1}{2}$ mm.; width 3–$5\frac{1}{2}$ mm.

Hab. Cape Colony (Cape Town, Stellenbosch, Paarl, Worcester).

* The livery of this rare varietal form is quite similar to that of *Coryna lugens* (pl. xxiv., fig. 123), which, however, does not belong to the same genus.

Var. HOTTENTOTA,

Plate XXIV., fig. 94.

The livery of this variety closely resembles that of *D. africana*, but the antennæ of the latter are wholly black.

DECATOMA LUNATA, Pall.,

Plate XXIV., fig. 95.

Icon., p. 79, pl. 79, pl. E., fig. 5*a b*; Thunb., Diss. Nov. Ins. Spec., vi., p. 3, fig. 15; Billb., Monogr., p. 55, pl. 6, fig. 4; Mars., Monogr., p. 583, pl. 6, fig. 10.

americana, Herbst., Füss. Arch., v., p. 146, pl. 30, fig. 5*a*.

cichorii, Wulf., Ins. Cap., p. 17, pl. i., fig. 3; Billb., Monogr., p. 55, pl. vi., figs. 6, 7.

Type: Black, clothed with dense long black hairs; the five basal antennal joints black, the others yellow, patches and bands of the elytra pale yellow; head and prothorax covered with fine, closely set, round, smooth punctures; elytra somewhat ampliated in the posterior part, covered with closely set moderately deep punctures with sub-rugose walls, on each side are a dorsal basal arcuate lunule reaching the suture, and a narrow elongated lateral patch, a nearly median transverse band narrowed by nearly one-half from the median dorsal part to the outer margin and with the lower edge bi-incised, and a post-median as broad as the anterior from the suture to the middle, narrowed thence to the margin, with the upper edge bi-sinuate, and the lower bi-incised, the outer incision being the deeper of the two; this band is often connected narrowly along the suture with the anterior; the pubescence is black on the black background, and flavescent on the yellow patches and bands, but in the centre of the apical black ground is a patch of flavescent hairs.

Length 12–17 mm.; width 14½–6½ mm.

Hab. Cape Colony (Cape Town, Stellenbosch, Paarl, Ceres, Worcester, Malmesbury, Knysna, Mossel Bay).

Var. OMEGA, Mars.,

Plate XXIV., fig. 96.

Monogr., p. 585, pl. 6, fig. 11.

Differs from the type in the pubescence being flavescent on the head and prothorax; on the elytra the dorsal arcuate lunule and the two transverse bands are broadly separated from each other, the inner part of the two bands is not so broad as in the type form, and the outer part has the two edges much more deeply incised.

Length 13–18 mm.; width 6–7 mm.

Hab. Everywhere in Natal and in the Transvaal.

Var. UMTALINA,
Plate XXIV., fig. 97.

Size, sculpture, and vestiture of the variety *omega*, but the basal dorsal arcuate lunule extends further down and thickens towards the suture, the median band is strongly slanting from the outer margin towards the suture, and is produced there into an elongated patch the outer angle of which reaches the posterior band, and is strongly narrowed and bi-dentate from the median dorsal part to the margin; the posterior band is as in *omega*.

Length 16 mm.; width 8 mm.

Hab. Southern Rhodesia (Umtali).

Var. DISPUTABILIS,
Plate XXIV., fig. 98.

Sculpture and vestiture of the other varieties; on the elytra the dorsal lunule is short and normally arcuate, the lateral patch is elongated into a short band, the anterior band is broad, the width being equal to about one-fourth of the whole length, and it is separated from the equally broad posterior band by a narrow strip of the black background, but it is connected laterally for a quarter of the width with the posterior band the hind margin of which is briefly, not deeply sinuate.

Length 22 mm.; width 9 mm.

Hab. Natal (Newcastle).

Var. SALISBURIANA,
Plate XXIV., fig. 99.

Sculpture and vestiture of the preceding species; on the elytra the basal dorsal lune is prolonged into a hamate band reaching nearly to one-third of the whole length, and the lateral patch into a narrow band reaching the anterior transverse band, each border of which is strongly bi-sinuate, the hind one forming a short sub-median spur narrowly connected with the posterior band which is narrowed from the middle to the outer margin, and the fore border of which is scooped in the centre, and the hind one is bi-incised.

Length 14 mm.; width 5 mm.

Hab. Southern Rhodesia (Salisbury).

Var. DIGRESSA,
Plate XXIV., fig. 100.

Like the variety *salisburiana*, but the apical part of the basal dorsal lunule is produced below the scutellary region into an elongated band

coalescing from the suture to the centre of the disk with the broader part of the anterior band, but leaving exposed along the suture a sub-triangular patch of the background; the anterior band is shaped as in *salisburiana*, but very nearly connected behind with the posterior the shape of which is similar to that of the variety above-mentioned, but a little wider towards the margin.

Length 15 mm.; width 5 mm.

Hab. Southern Rhodesia (Salisbury).

Var. RHODESIANA,

Plate XXIV., fig. 101.

Sculpture and vestiture of the preceding varieties; on each elytron the basal dorsal lunule has invaded the whole basal part except for a small quadrate black patch below the scutellum, and has become entirely connected with the anterior band suffusing thus with yellow the anterior half, the hind margin of that yellow suffusion emits a short spur along the suture, and is bi-denticulate from the centre to the outer margin, the posterior band is narrow and greatly attenuated and deeply bi-incised on each border from the centre to the outer margin.

Length 13½ mm.; width 6 mm.

Hab. Southern Rhodesia (Umtali).

Var. LYDENBURGIA,

Plate XXIV., fig. 102.

In this variety the basal dorsal lunule has also invaded the whole anterior part, but there is a median dorsal small spot of the background showing at about one-third of the length, and the spur emitted near the suture is very narrowly connected at a short distance from it with the posterior band the shape of which is similar to that of the variety *rhodesiana*, but is wider.

Length 17 mm.; width 7 mm.

Hab. Transvaal (Lydenburg).

Var. JOHANNIS,

Plate XXIV., fig. 103.

Very distinct from all the varieties of *D. lunata*. The pubescence is black, as in the type form, and there is also no silky flavescent patch of hairs above the apex of the elytra; the sculpture is, however, identical. The basal dorsal lunule is slightly elongate arcuate but does not reach the suture; the anterior band is of equal width, but very narrow and narrowly interrupted above the outer margin, the hind border is more sinuate

towards the median part than the anterior, which is nearly straight, the supra-marginal patch is, however, broader than the uninterrupted part of the band; the posterior band which does not begin at the very suture is still narrower than the anterior, and more broadly interrupted past the centre.

Length 19 mm.; width 7½ mm.

Hab. Transvaal (Johannesburg).

DECATOMA SOBRINA, n. sp.,
Plate XXIV., fig. 104.

Black, covered with a dense sub-flavescent pubescence; the five basal antennal joints are black, the others yellow; on the elytra the lunules and bands are yellow; head and prothorax closely, and only moderately, unevenly punctured; frontal part without any distinct longitudinal smooth line; elytra very closely punctate, sub-shagreened; they have on each side an elongated arcuate lunule beginning in the basal dorsal part, but with the curved part not quite connected with the suture, an elongated lateral patch, a very narrow sub-median transverse band deeply and broadly bi-sinuated on either border, and occasionally slightly interrupted in the centre, and a somewhat broader post-median band also broadly sinuated on either border, but with the part extending from the suture to the median dorsal part broader than in the anterior; the flavescent pubescent patch on the hind part of the elytra is also fairly distinct.

Length 9 mm.; width 3½ mm.

Hab. Natal (Howick).

DECATOMA TRANSVAALICA, Pér.,
Plate XXIV., fig. 105.
Ann. S. Afric. Mus., vol. iii., 1904, p. 284.

Black, with the head, prothorax, scutellum, abdomen, pectus, and legs clothed with a very dense, silky, yellowish pubescence; antennæ black with the exception of the 3–5 joints which are red or reddish flavescent; head somewhat broadly and deeply punctate, and with a faint, short, smooth line abutting on the transverse impression of the epistome; prothorax of the normal shape, covered with contiguous, deep, not broad, but slightly scrobiculate punctures, and having a very slight median impression; scutellum closely punctate; elytra sub-cylindrical, hardly wider across the posterior part than at the base, finely shagreened, bi-costulate on each side in the dorsal part, clothed with an appressed, brief, slightly flavescent pubescence, pale yellow, somewhat straw-colour with a narrow basal and lateral fulvous margin which disappears, however, when the colour turns to reddish fulvous, which is occasionally the case, and having

on each side a narrow humeral longitudinal black band, two series of three equi-distant spots or patches disposed diagonally from the suture to the outer margin, and a supra-apical diagonal arcuate patch consisting evidently of two gglomerated apatches the outer of which reaches the outer margin which from there to the suture is moderately narrowly black. Easily recognised by the colour of the antennæ.

Length 7½–13 mm.; width 3–4½ mm.

Hab. Transvaal (Potchefstroom, Waterberg, Zoutpansberg); Southern Rhodesia (Bulawayo, Plumtree, Gwanda).

DECATOMA UNDATA, Thunb.,
Plate XXIV., fig. 106.

Dissert. Nov. Ins. Sp., vi., p. 114, f. 17; Billb., Mon., p. 40, pl. 4, figs. 16, 17; Mars., Mon., p. 573, pl. 6, fig. 2.

undatobifasciata, De Geer., Ins., vii., p. 649, pl. 48, figs. 15, 16.

Black, clothed with a black pubescence, but flavescent on the narrow yellow bands of the elytra and in the posterior part of the same; antennæ black, the apical joint swollen outwardly at about the median part, and on that account sharply acuminate at the apex; head and prothorax deeply and closely punctulate, the punctures plainly rugose, frontal part with an indistinct smooth patch; elytra deeply punctate shagreened, each with a yellow basal dorsal lunule the arcuate patch of which reaches the suture, and a narrow humeral line continued along the outer margin and connected there with the very narrow ante-median yellow band both edges of which are broadly but not very deeply bi-sinuate, the post-median band is not broader than the anterior, and has very nearly the same shape, the part of the anterior band abutting on the outer margin is occasionally prolonged behind there for a short distance. The last joint of the antennæ is strongly swollen outwardly, more so than in any other species of South African *Decatoma*.

Length 9½ mm.; width 3½ mm.

Hab. Cape Colony (Cape Town, Stellenbosch, Paarl, Worcester, Ceres, Malmesbury).

DECATOMA STELLENBOSCHIANA, n. sp.,
Plate XXIV., fig. 107.

This may prove to be only a varietal form of *D. undata*, but the punctuation of the elytra is deeper, broader, more irregular, and the latter are therefore more shagreened; on each elytron the basal dorsal yellow lunule has become coalescent along the suture and also on the dorsal part, the anterior band including thus between the median dorsal part and the

suture a moderately large patch of the black background, the humeral patch is continued along the margin as a narrow band coalescing there with the anterior band the hind border of which is produced behind along the suture as a sub-quadrate projection, and is bi-sinuate thence to the outer margin, the post-median band is narrow, of nearly equal width throughout, and each border is plainly bi-sinuate; the apical flavescent pubescent patch is distinct. The last joint of the black antennæ is similar in shape to that of *D. undata*.

Length 8 mm.; width 3½ mm.

Hab. Cape Colony (Stellenbosch).

DECATOMA CONTORTA, Péring.,
Plate XXIV., fig. 108.

Trans. S. Afric. Phil. Soc., iv., 1888, p. 132, pl. 3, fig. 6.

Allied to *D. undata*, which it seems to replace in the Transvaal. It is somewhat larger; the pubescence on the head and prothorax is silky flavescent instead of being greyish black, and the sculpture is more closely set, but that of the elytra is almost similar; the last joint of the antennæ is strongly swollen outwardly in the manner of *D. undata* and *stellenboschiana;* on the elytra the outer part of the basal dorsal lunule is prolonged as far as the fore edge of the median part of the anterior transverse fascia of which, like in the post-median one, both edges are very sharply tri-sinuate.

Length 11 mm.; width 4½ mm.

Hab. Transvaal (Potchefstroom, Bocksburg, Pietersburg); Cape Colony, Bechuanaland.

I have seen examples in which the bands of the elytra are as narrow as in examples of *D. undata*, from which they can be distinguished only by the less swollen apical joint of the antennæ.

DECATOMA AFRICANA, Oliv.,
Plate XXIV., figs. 109, 110.

Entom., iii., 47, p. 12, pl. 2, fig. 21; Mars., Mon., p. 571, pl. 6, fig. 4.

? *decipiens*, Mars., p. 574, pl. 6, fig. 3.

Black, covered with a pubescence greyish underneath, black and greyish flavescent on the prothorax, and black on the elytra even on the yellow patches or bands; antennæ black; head and prothorax very closely pitted, the punctures separated by narrow, raised, irregular walls, frontal part with a not very distinct median line; elytra very closely pitted, the punctures forming a shagreened surface on the black background, but with the intervals smooth on the pale yellow part which, in

the type form (fig. 109), invades the greatest part of the surface, the suture is narrowly black from the scutellum to about one-fourth of the length where it expands into a quadrate black patch extending on each side, and at about the middle is a small, sub-triangular dot; on the humeral part is a long black band slightly broader at apex than at base and reaching from there to one-fourth of the length; at about the median part is a sub-quadrate black dorsal patch, and the apical part is also black, the lower edge of the yellow part being there denticulate and sinuate; the supra-apical flavescent patch is somewhat reduced.

Length 14–16 mm.; width $5\frac{1}{2}$–$6\frac{1}{4}$ mm.

Hab. Cape Colony (Ceres, Stellenbosch, Worcester).

The normal form (fig. 110), which is the rarer of the two, has on each elytron a basal dorsal comma-shape patch and a lateral band connected along the margin with the anterior transverse band which is triangularly dilated along the margin, strangulated in the centre, irregularly dilated along the suture and sending close to it a hind spur which does not reach the posterior band, the latter is slightly broader and shaped in the same manner, viz., the anterior border is incised in the centre, the posterior is straighter along the suture and narrowly bi-incised thence to the outer margin.

Length 14–17 mm.; width 6–$6\frac{1}{2}$ mm.

Hab. Cape Colony (Cape Town, Stellenbosch, Malmesbury).

Var. INSOLITA,

Plate XXIV., fig. 111.

Size, shape, and colouration of *D. africana;* the pubescence on the head and prothorax is, however, more flavescent, and the punctuation of the prothorax is not so deep and is slightly more irregular; there is on each side a somewhat large basal dorsal patch the inner edge of which reaches close to the suture, the patch itself being slightly slanting towards it, the lateral patch is narrow but as long as the dorsal, the anterior yellow band which, like the post-median one, reaches from the suture to the outer margin without any connection along the margin is somewhat broadly scooped in the centre of the border, the hind one is 3-incised and emits near the centre of the disk a spur which occasionally reaches as a narrow streak the post-median band which is not broader than the anterior, and is as deeply but more narrowly scooped in the centre of the anterior border, while the strongly bi-sinuate hind border emits a central, elongate rounded lobe.

Length 12–15 mm.; width 5–6 mm.

Hab. Cape Colony (Kimberley).

The pattern of the elytra is not unlike that of a varietal form of *D. africana*, but the bands and lateral patch are not connected along the outer margin, and the median prolongation behind of the hind border of the posterior band is very different. I have seen two examples only, and on that account I hesitate to propose this variety as a valid species.

DECATOMA QUADRIGUTTATA, Wulf.,
Plate XXIV., fig. 112.

Insect. Capens., p. 18, pl. 1, fig. 7*a b*; Billb., Monogr., p. 44, pl. v., fig. 4.
nigricornis, Mars., Monogr., p. 577, pl. 6, fig. 5.

Black, clothed underneath with a black pubescence; on the prothorax the pubescence consists of black erect hairs mixed with a few flavescent greyish ones; antennæ black, the last joint elongated, acute at tip; head and prothorax closely scrobiculate punctate; elytra closely shagreened and each with three moderately distinct costules; they have on each side a round basal dorsal pale yellow patch, a briefly elongated lateral one, an anterior somewhat narrow band reaching from the suture to the outer margin, bi-sinuate on each side or slightly strangulate at about the middle, and a post-median one broader than the anterior, scooped in the centre of the anterior border, bi-incised or less deeply scooped in the posterior, the part of the band abutting on the outer margin narrower than that abutting on the suture.

Var. MINUTA,
Plate XXIV., fig. 113.

Casteln., Hist. Nat. Ins., ii., 1840, p. 268; Billb., Monogr., p. 44, pl. v., fig. 3; Mars., Monogr., pl. 6, fig. 6.
4-*guttata*, Mars. *nec* Wulf., pl. 6, fig. 7.

Similar to the type; the two basal patches are alike, but the anterior and post-median patches are very distinctly interrupted in the centre of the dorsal part. These yellow markings form thus a juxta-sutural series of three sub-transverse patches and a marginal series of slightly narrower, and with the exception of the humeral, more transverse patches.

Length 10–15 mm.; width 4–6 mm.

Hab. Cape Colony (Cape Town, Stellenbosch, Paarl, Worcester).

DECATOMA NAMAQUA, n. sp.,
Plate XXIV., fig. 114.

Like *D. quadriguttata*, but the punctures on the head, and the prothorax especially, are somewhat wider and coarser, and on the latter is a

very plain longitudinal smooth line; on the elytra the three costules of each are very plain, the three juxta-sutural patches are replaced by a mere yellow dot, but the outer marginal patches are only slightly smaller than in *D. quadriguttata*.

Length 14–16 mm.; width 5½–6½ mm.

Hab. Cape Colony; Namaqualand.

This is very closely allied to the preceding one, and may prove to be only a varietal form, but it occurs only in Namaqualand, where it seems to be very constant.

Decatoma adamantina, Péring.,
Plate XXIV., fig. 115.
Trans. S. Afric. Phil. Soc., viii., 1888, p. 131, pl. 3, fig. 7.

Black, clothed underneath with a dense black pubescence, on the head and prothorax this pubescence is not very dense, and it is extremely short and almost invisible on the elytra except in the posterior part; antennæ yellow with the two basal joints black, patches and bands on the elytra yellow except the supra-apical patch which is red; head and prothorax punctate, punctures round, smooth, and set moderately close to each other but not contiguous at the apex of the head and on the posterior part of the prothorax; elytra with the three costules distinct, punctate shagreened on the black background, less shagreened on the yellow patches and bands which are disposed as follows: a basal dorsal large rounded patch coalescing or nearly coalescing with an equally large lateral patch, anterior band moderately broad, bi-sinuate in the fore border, tri-sinuate in the posterior and also dentate there, posterior band as broad as the anterior and equally bi-sinuate, but without the tooth; at an equal distance from this band and from the apical border, and set in the inner part of the disk is an ovate red patch.

Length 15–19 mm.; width 5–7 mm.

Hab. Cape Colony (Victoria West, Beaufort West, Kimberley).

Decatoma histrio, Mars.,
Plate XXIV., figs. 116–117.
Monogr., p. 581, pl. 6, fig. 8.

Black, clothed on the under and upper sides with a very dense flavescent greyish pubescence, appressed but also dense on the elytra; antennæ black but with the joints 3 and 4 slightly rufescent; head and prothorax very finely and closely punctate; elytra with only the median dorsal costule usually distinct, the black background is closely and finely shagreened, the pale yellow bands and patches being deeply but not

closely punctulate, on each side is a basal dorsal transverse or sub-arcuate patch set at a short distance from the base, and a lateral small one; the anterior band is narrow, deeply scooped at about the median part of the anterior border and emits on the posterior border a straight median spur, the post-median one is of the same shape, and the spur is occasionally connected with a slanting yellow or occasionally orange-red posterior patch with the fore border bi-incised and the hind one with only one incision.

Length 12½–16 mm.; width 4½–5 mm.

Hab. Cape Colony (Victoria West, Beaufort West, Uniondale, Grahamstown, Uitenhage, Fort Beaufort).

Gen. CORYNA, Billb.,

Plate XXIV., fig. 118.

Monogr. Mylabr., 1813, p. 73.

Antennæ 9-jointed, apical joint very swollen and convex outwardly.

Key to the Species.

A^2. The five basal antennal joints black, the others yellow, legs black.

Elytra with a dorsal and a lateral basal patch, two transverse bands and one apical patch.

Body densely pubescent; basal dorsal lunule continued as an elongated band connected by a narrow spur or line with the anterior transverse band which is interrupted laterally, the humeral band is prolonged as a narrow marginal band from the base to the apical patch which is strongly constricted in the centre (pl. xxiv., fig. 119) *pilosa.*

Basal dorsal lunule forming a quadrate patch connected with the entire median band, the lateral humeral band continued along the whole margin (pl. xxiv., fig. 121) .. .. var. *distincta.*

The two median transverse bands coalesce, forming a broad band with an M-shaped black patch in the middle .. .. var. *cinctuta.*

Basal dorsal lunule coalescing with the anterior band which coalesces also with the post-median one, forming thus a very broad yellowish band with two spots of the background left, lateral band connected along the margin with the transverse band (pl. xxiv., fig. 122) .. .. var. *matabelene.*

Body very little pubescent, transverse bands not connected along the outer margin (pl. xxiv., fig. 120) .. .. *apicipustulata.*

A^3. The four basal antennal joints black, the others yellow.

Elytra each with three dorsal round yellow patches and three lateral marginal ones (pl. xxiv., fig. 123).. .. .. *lugens.*

A². All the antennal joints rufescent; legs also rufescent.

Elytra with a lateral flavescent uninterrupted border, a basal transverse marginal band connected near the suture with the first of three seriate round dorsal patches, and three lateral patches connected with the outer border (pl. xxiv., fig. 124) .. .. *argentata.*

A¹. The two basal joints of antennæ black, the others yellow.

Outer margin with a broad band beginning at the shoulder, ampliate in the middle, not reaching the rounded apical part, basal lunule nearly longitudinal, median band bi-sinuate, connected with the lobate part of the margin, second band interrupted at the suture and towards the margin; no apical patch .. .. *mylabroides.*

CORYNA PILOSA, Fåhr.,
Plate XXIV., fig. 119.
Öfv. Vet. Ak. Förh., 1870, p. 347.

mixta, Mars., Monogr., p. 605, pl. 6, fig. 7.
posthuma, Mars., *loc. cit.*, p. 603, pl. 6, fig. 6.

Black, clothed on the lower and upper side with a very dense, silky flavescent pubescence much shorter and more appressed on the elytra than on the head and prothorax; antennæ with the five basal joints black and the other four rufo-flavescent; head and prothorax closely punctate, the punctures not rugose, frontal part with a very plain raised line; elytra elongated, punctate shagreened, patches and bands yellow, on each side are a basal dorsal lunule the curving inward part of which reaches the suture, and a lateral marginal short band, reaching the anterior transverse band which is moderately deeply bi-incised on each border between the suture and the median dorsal part, narrowly interrupted there, and continued to the margin; the posterior band is equally narrow with each border bi-sinuate or bi-incised; in the apical part are two coalescent macules forming a slanting patch strangulated in the centre. In many examples from Northern Damaraland the outer apical angle of the basal dorsal lunule is narrowly connected with the median part of the anterior band.

Length 12–14 mm.; width 4–5 mm.
Hab. Northern Damaraland; Ovampoland.

Var. DISTINCTA,
Plate XXIV., fig. 121.
Voigts, Wien. Ent. Zeit., xxi., 1902, p. 177.

apicalis, Pér., Trans. S. Afr. Phil. Soc., viii., 1886, p. 133 (nam. preocc.).

Size and shape of the type form *C. pilosa*, and equally densely flavous pubescent, but differs by the disposition of the yellow markings on the

elytra; the two basal lunules have become a quadrate patch, connected on the outer side by a narrow line with the median transverse band which is broader than in the type form and more sharply zigzagged; the humeral narrow band is continued along the margin and joins the apical patch at the apex.

Length 12 mm.; width $4\frac{1}{2}$ mm.

Hab. Transvaal (Potchefstroom, Lydenburg).

Var. CINCTUTA, Mars.,
Monogr., p. 600, pl. 6, fig. 4.

In this variety the two median transverse yellow bands have coalesced, forming thus a single broad band having however in the centre an **M**-shape patch of the colour of the background, and a small triangular black notch along the suture.

Length 13 mm.; width $3\frac{3}{4}$ mm.

Hab. Kaffraria, teste Marseul.

I have not met with this variety, of which the var. *matabelena* is an extreme form.

Var. MATABELENA,
Plate XXIV., fig. 122.

Smaller than the type form; the lower part of the dorsal lunule is produced into a large quadrate patch reaching the suture, the outer angle is connected with the anterior band which has coalesced with the post-median forming thus a very broad yellow area equal in width to half the length of the elytra, and enclosing three small dot-like spots in the centre of the disk, the lateral basal band is connected with the broad yellow band the hind border of which is tri-dentate; the apical patch is of the normal shape.

Length 9 mm.; width 4 mm.

Hab. Southern Rhodesia (Bulawayo).

Var. APICIPUSTULATA, Mars.,
Plate XXIV., fig. 120.
Monogr., p. 602, pl. 6, fig. 5.

Black, clothed underneath with a short black pubescence which on the head and prothorax is mixed with sub-flavescent hairs; on the elytra the pubescence is short, flavescent on the yellow patches and bands, black on the black background, whereas in *C. pilosa* it is longer, denser, and entirely flavescent; the five basal antennal joints are black, the other four flavous; head and prothorax very closely punctate; elytra very

closely punctate, not shagreened, but the punctures are slightly rugose; bands and patches bright yellow, on each side are a basal dorsal lunule strongly arcuate at apex towards the suture which it reaches, and a lateral short marginal band, the anterior transverse band is straight in the fore border, the hind one is dilated close to the suture and moderately deeply bi-sinuate from the middle to the outer margin, the post-median band is narrower than the anterior, attenuated from the middle to the outer margin and with each border bi-incised there, the apical patch is plainly divided into two.

Length 14–15 mm.; width 6–6½ mm.

Hab. Natal? (Durban).

CORYNA LUGENS, Fähr.,
Plate XXIV., fig. 123.
Ofv. Vet. Ak. Förh., 1870, p. 347.

wahlbergi, Mars., Mon., p. 612, pl. 6, fig. 13.

Black, clothed underneath and on the head and prothorax with a dense appressed flavescent pubescence, on the elytra the pubescence is very short, but dense; the four basal antennal joints are black, the other five rufo-flavescent; head and prothorax deeply pitted, the punctures rugose on the frontal part which bears no traces of a median line, and in the anterior part of the prothorax, more even in the posterior; elytra closely punctate shagreened, especially on the lateral part, each one has a juxta-sutural longitudinal row of three rounded pale yellow patches, the first basal, the second median, the third post-median, and along the outer margin are also three patches, the first is humeral, and the other two which are quadrate or sub-triangular are situated nearly opposite the juxta-sutural ones.

Length 9–11 mm.; width 4½–4¾ mm.

Hab. Natal (Durban, Isipingo).

CORYNA ARGENTATA, Fabr.,
Plate XXIV., fig. 124.
Ent. Syst., ii., 1791, p. 90.

Black, with the palps, the whole antennæ, the legs and tarsi rufescent; the whole body is thickly clothed with an appressed golden-yellow pubescence, and the head, prothorax, and elytra bear in addition dense erect hairs flavescent on the two first-named parts and black on the elytra; head very closely punctate; antennæ short, intermediate joints small, closely set, apical one thickly clubbed, and intermediate in thickness with that of the other species of the genus and of *Actenodia;*

prothorax as closely punctate as the head; elytra somewhat deeply pitted, the punctures separated from each other by an interval almost equal to their own diameter, and without any traces of costules; each one has a very plain uninterrupted dark orange-yellow border reaching from the humeral part to the suture, and broader on the rounded apical part, a transverse marginal narrow basal band, curving outwards at a short distance from the suture and uniting with the first of three somewhat large, transverse rounded, seriate, dorsal, dark orange-yellow patches the last of which is situated at about three-fourths of the length; on the lateral part are three sub-triangular patches not in a line with the three dorsal ones, and with their base connected with the lateral border; occasionally the apex of the second lateral patch is connected upwards with the second dorsal patch.

This species is easily recognised by its thick golden-yellow vestiture.

Length 8–10 mm.; width 3½–4 mm.

Hab. Mozambique (Beira). It is evidently a straggler. The species is recorded from Egypt, Senegal, and India (Bengal).

Species not identified.

CORYNA (MYLABRIS) 12-GUTTATA (Klug),
Germ. Spec., 1824, 171, 283.

"Bristling with hairs, black; elytra adorned with six round flavous spots. Small, entirely black, punctate, elytra adorned with six round flavous spots: first oblong, situated behind the shoulder, second near the scutellum, third and fourth before the middle, fifth and sixth beyond it. Cape of Good Hope."

CORYNA MYLABROIDES, Cast.,
Hist. Nat. Ins., ii., 1840, p. 208; Mars., Monogr., p. 607, pl. 6, fig. 8.

lanuginosa, Gerst., Monatsb. Berl. Ac., 1854, p. 695; Peter's Reis., 1862, p. 303, pl. 18, fig. 4.

Elongated, sub-parallel, little convex, black, moderately shiny, clothed with a greyish silky pubescence; head closely punctate like the prothorax, inflated behind the reniform eyes, frontal part convex, labrum bi-lobate, &c., antennæ red with the two basal joints black; pronotum hardly oblong, dilated, rounded externally, coarctate and narrowed in front, reflexed at base, moderately convex and bi-impressed in the dorsal part; scutellum lobate; elytra with the shoulders raised, rounded at apex, densely reticulate punctate with the nervures obsolete, the three marginal pale yellow macules are connected, the median one being ampliate lobate, and connected with the median, sub-oblique patch, the lower margin is

strongly bi-sinuate, the basal lunule is narrow, nearly longitudinal, and opposite the lobate part of the third marginal macule is a transversely oblong median one.

I have not met with this species, the description of which is partly culled from Marseul, and partly made from the figure he gives in his *Monographie des Mylabres*. It differs from *C. pilosa* and varieties of the same in the disposition of the pale yellow bands the third dorsal one of which is broadly interrupted, and there is no apical patch; in addition to this difference only the two basal joints of antennæ are black, whereas in *C. pilosa* the five basal joints are of that colour.

Length 11 mm.; width $3\frac{1}{2}$ mm.

The species is recorded from Egypt, Angola, and Mozambique.

Gen. ACTENODIA, Cast.,
Plate XXIV., fig. 125.
Hist. Nat. Ins., ii., 1840, p. 268.

Antennæ 8-jointed, apical joint very swollen, especially on the outer side where it is very convex.

Key to the Species.

A^3. Patches and bands of elytra pale yellow; two basal patches and two transverse bands.

A basal dorsal round, and a lateral arcuate pale yellow patch, anterior band interrupted in the centre, posterior formed by two transverse patches broadly coalescing in the centre (pl. xxiv., fig. 126) .. .. *decemguttata*.

Patches and bands of elytra orange-yellow or orange-red.

The same but the anterior band is not interrupted in the centre although strongly constricted there, posterior band broad, not reaching the apex, and with both edges sinuate (pl. xxiv., fig. 127) .. *curtula*.

B^2. Antennæ black.

A^2. Patches and bands of elytra orange-yellow; basal patches and anterior band united; posterior invading the apex.

Elytra orange-yellow, with a broad, transverse bi-sinuate band not reaching quite the outer margin, a post-median bi-dentate one extending from side to side, a supra-apical dot, and a marginal apical band black (pl. xxiv., fig. 128) .. .. *chrysomelina*.

B^1. Antennæ yellow with the two basal joints black.

The same, but with the anterior band reduced to a triangular patch along the suture, a dorsal minute black spot (pl. xxiv., fig. 129) .. .. *discrepans*.

A[I]. Elytra with two longitudinal series of yellow patches, apical margin yellow.

Elytra each with four round pale yellow patches disposed longitudinally in the dorsal part, and three lateral supra-marginal ones connected with the yellow margin which runs from the base to the apex, and is broader there than laterally (pl. xxiv., fig. 130) .. .. *jucunda.*

Elytra with three orange-red dorsal patches, a humeral and two lateral ones, the outer margin is broadly orange-red from past the middle where it is connected with the second lateral patch, to the rounded apex (pl. xxiv., fig. 131) .. .. *amoena.*

ACTENODIA DECEMGUTTATA, Thunb.,

Plate XXIV., fig. 126.

Nov. Spec. Ins., vi., 1791, p. 234, pl. xi., fig. 13; Billb., Mon., pp. 45, 31, pl. 5, fig. 5.

guttata, Cast., Hist. Nat. Ins., ii., 1840, p. 268, fig. 192.

Black, clothed with a dense, black pubescence also very long on the elytra, but appressed there ; head and prothorax covered with deep, closely set punctures, confluent, and with raised walls on the prothorax ; antennæ entirely back ; elytra coriaceous shagreened with the costules indistinct, the bands and patches are pale yellow and disposed as follows : a basal dorsal ovate patch, and a lateral marginal elongated one, a sub-median juxta-sutural ovate patch, and opposite a triangular marginal one reaching very close to it, a post-median band consisting plainly of two more or less ovate patches broadly connected at each end.

Length 9½ mm. ; width 4½ mm.

Hab. Cape Colony (Cape Town, George).

ACTENODIA CURTULA, Fåhr.,

Plate XXIV., fig. 127.

Öfv. Vet. Ak. Förh., 1870, p. 349.

rufonigra, Mars., Mon., p. 628, pl. 6, fig. 5.

Shape and size of *A. decemguttata*, from which it differs in the less deeply punctate prothorax, and with the intervals of the punctures plane instead of being produced into a raised wall ; the black pubescence is also much shorter on the upper side ; all the antennæ joints are totally black ; the patches and bands of the elytra are orange-yellow ; in the type form the basal dorsal and lateral marginal patches are small and clearly defined, the ante-median band is complete with each border deeply bi-sinuate, the post-median band is broader from the suture to about the median part

and narrowed thence to the outer margin with the two borders bi-incised.

Length 10 mm.; width 4¼–4½ mm.

Hab. Cape Colony (Dunbrody), Natal (Eshowe, Durban).

ACTENODIA CHRYSOMELINA, Erichs.,
Plate XXIV., fig. 104.

Wiegm. Arch., 1843, p. 258; Mars., Monogr., p. 629, pl. 6, fig. 6.

wahlbergi, Fähr., Öfv. Vet. Ak. Förh., 1870, p. 349.

Black, clothed with a dense black pubescence on the under side and on the head and prothorax; this pubescence is also very long and erect, but less dense on the elytra; it is also often totally wanting on the upper side; all the antennal joints black; the punctures on the head and prothorax are somewhat scattered and shallow with the intervals smooth; the elytra are closely coriaceous on the orange-yellow parts, finely punctate on the black, and the costules are moderately distinct; the orange-yellow basal patches and the ante-median bands have invaded nearly the whole of the anterior part of the disk, including however a triangular sutural patch, a smaller more central one, and a minute dot disposed transversely, all three being the remains of the band of the black background that separated the two anterior bands from the basal patches; the post-median band has also invaded the whole posterior part, except for a narrow apical black border, and a minute black dot in the centre of that broad patch.

Length 6–9½ mm.; width 2–4½ mm.

Hab. Transvaal. The whole of the Transvaal, Mozambique, Ovampoland, Damaraland. Has not to my knowledge been recorded as yet from Natal, nor from the Cape Colony.

ACTENODIA DISCREPANS, n. sp.,
Plate XXIV., fig. 129.

Resembles almost completely the type form of *A. chrysomelina;* but the colour of the antennæ differs, the antennal joints with the exception of the two basal ones which are black, being flavo-rufescent, but joints 3 and 4 are somewhat dull yellow; in the elytra the orange-yellow colour has invaded nearly the whole of the anterior part except for a small triangular, sutural black patch and a smaller one often reduced to a mere dot in the centre of the disk; the whole posterior part is orange-yellow except for a minute median dot and a very narrow fringe of the apical margin which are black.

Length 9–9½ mm.; width 4½ mm.

Hab. Transvaal (Middle Limpopo; Waterberg).

ACTENODIA JUCUNDA, Erichs.,
Plate XXIV., fig. 130.
Wiegm. Arch., i., 1843, p. 257.

Black, clothed with a very dense, partly appressed flavescent, silky pubescence; legs rufo-flavescent with the knees infuscated and the tarsi black; labrum rufescent; antennæ black; prothorax very elongated, one-third longer than broad, and much attenuated in front, both the head and prothorax are very closely punctulate, the punctures small, but deep and rugose; elytra punctate shagreened and with some erect hairs in addition to the sub-appressed flavescent pubescence, the patches are pale yellow and disposed as follows: four sub-median dorsal ones, somewhat ovate, the fourth situated at about four-fifths of the length, three lateral marginal, sub-triangular ones set opposite the corresponding dorsal ones, but all connected along the margin by a narrow pale flavescent band running from the humeral basal part to the rounded part of the suture and wider in the apical part than along the lateral margin. I have seen examples in which the legs are totally black.

Length 7–8 mm.; width $2\frac{1}{2}$–$2\frac{3}{4}$ mm.

Hab. Southern Rhodesia (Sebakwe), Ovampoland.

ACTENODIA AMOENA, Mars.,
Plate XXIV., fig. 131.
Monogr., p. 621, pl. vi., fig. 1.

Black, clothed with a short, silky flavescent pubescence; tibiæ rufescent; antennæ black; head and prothorax very closely, and somewhat roughly punctate, the punctures small and confluent; prothorax elongated, one-third longer than broad, much attenuated in front; elytra plainly shagreened, with the patches orange-yellow and disposed as follows: three juxta-sutural somewhat ovate rounded ones, the first basal and more elongated than the other two, the second median, the third post-median, along the outer margin is a humeral elongated patch disconnected from the second and the third which are prolonged along the margin and situated slightly above the opposite dorsal ones; the posterior however is continued along the margin right to the suture, thus forming in the apical part a plain, moderately narrow band. In this species the apical antennal joint is much more elongated and much less club-shaped than in the other South African species known to me.

Length 8 mm.; width 3 mm.

Hab. Cape Colony (Namaqualand).

Actenodia villosa, Mars.,
Monogr., p. 625, pl. vi. (iv.), fig. 3.

Marseul, *loc. cit.*, describes an *Actenodia* which differs from *A. amoena* merely by having all the antennal joints, the basal parts, and the legs yellow. The habitat of this species, "Cape of Good Hope," is however considered by him as doubtful. I have not met with it.

Gen. PARACTENODIA, Péring.,
Ann. South Afric. Mus., iii., 1904, p. 285.

Characters of *Actenodia*, Casteln., from which it differs in the number of antennal joints which is seven instead of eight.

Paractenodia parva, Péring.,
Plate XXIV., fig. 132.
Loc. cit., p. 285.

Black, with the five ultimate joints of the elytra and the tibiæ red; covered with a very short, appressed silky pubescence; head deeply and closely punctate and with a faint, smooth, longitudinal area in the middle of the frontal part; prothorax only moderately narrowed laterally in the anterior part, as broad as long, scrobiculate punctate with the punctures very closely set, and plainly impressed longitudinally in the posterior part; elytra coarsely shagreened, without any costules, patches and bands yellowish red, the anterior elongated band is formed by a longitudinal basal patch reaching the median bi-sinuate transverse band which is disconnected from the suture, but continued upwards into a somewhat broad band along the outer margin as far as the humeral part where it coalesces anew with the basal patch which has invaded all the base, this basal band reaches the suture in the anterior part only, and the result of the amalgamation of this basal patch and band gives to the elytra the appearance of being yellowish red from the base to the median part, except for a narrow strip along part of the suture, and enclosing a humeral, narrow black band; the second band is equidistant from the first and from the apex, strongly sinuate and narrowly disconnected from the suture, but not from the outer margin. The last joint of the antennæ which is nearly equal in length to the four preceding ones taken together, is very thick, but arcuate as in *Coryna*.

Length $4\frac{1}{2}$–5 mm.; width $2\frac{1}{2}$ mm.

Hab. Cape Colony (no exact locality).

Tribe CANTHARINI.

Maxillary lobes normal in shape; antennæ always 11-jointed, more or less compressed, of variable shape, but never with the last joint knobby; prothorax mostly campanulate, but occasionally sub-transverse; elytra broad, sub-depressed (*Eletica*), or more or less cylindrical; legs long, somewhat compressed laterally, tarsi always long, variable in shape; claws usually cleft from apex to base, but there are exceptions in the South African species in which moreover the upper part of the said claw is always simple.

Key to the Genera.

A². Head not acuminate in front.

B². Elytra broad, depressed.

a^3. Antennæ short, the joints serrate or strongly serrate inwardly; tarsal joints short, very broadly triangularly incised .. .. *Eletica.*

B¹. Elytra cylindrical or sub-cylindrical.

a^2. Antennæ longer, the joints flabellate inwardly. Tarsal joints not triangularly incised .. .. *Prionotolytta.*

a^1. Antennæ neither serrate nor flabellate inwardly.

Antennæ very long and greatly compressed; body dark blue or blue-black, pectus with a conspicuous red patch .. .. *Cyaneolytta.*

Antennæ very long, filiform, mandibles strongly developed, vaulted and curving backwards .. .. *Psalydolytta.*

Antennæ long or short, mandibles normal, pubescent or glabrous, pectus without a red patch .. .. *Cantharis.*

Gen. ELETICA, Lacord.,

,Plate XXII., fig. 5*a*.

Gen. d. Coléopt., v., 1859, p. 672.

Mentum transverse, ampliate laterally, with the upper angles rounded, and the basal ones sharp, concave, ligula as long as the mentum, membranaceous, so broadly and deeply scooped as to be bi-lobate, labial palps short; apical joint cylindrical, implanted on the penultimate which is elongate conical; maxillæ robust, inner lobe broad, densely ciliate pubescent, upper lobe sub-spatuliform, also densely ciliate pubescent; maxillary palps short, first and second joints of nearly equal length, third shorter, conical, last one sub-pyriform; antennæ short, not reaching the shoulders strongly compressed, intermediate joints thickly serrate outwardly, more closely set in the male than in the female, apical joint slightly coarctate, and

looking as if divided into two; mandibles robust, sharply falcate; labrum moderately short, scooped in the centre; head sub-quadrate, frontal part strongly sloping, gibbose; prothorax longer than broad, with the anterior part strongly attenuate and sloping, and the posterior one convex; base plainly marginate; scutellum broadly triangular, but sub-truncate at apex; elytra elongated, sub-parallel, plane past the basal part; bi-costulate on each side, but with the two costæ and two other intervening ones highly carinate in the basal part for about one-fourth of the length in the ♂; in the ♀ these intervening costæ are not much more raised than the costules; five visible abdominal segments in both sexes, the apical one much narrower in the ♂ than in the ♀; legs moderately long; tarsi with the intermediate joints very broadly triangular and deeply incised in the ♂, more elongated and narrower in the ♀; claws double, the upper tooth strong, compressed and dilated at the base, bent almost at right angles there, the lower claw in the shape of a stiff bristle; outer spur of hind tibiæ sub-spatulate, short, inner one not longer than the outer, moderately acute.

Few Coleoptera vary more in colouration than the species included in this genus. This variation is not restricted to sex only. It is quite possible that one of the South African species may prove identical with *E. rufa*, of the Guinea coast. Several species have been described from German and British East Africa, and one from Somaliland.

Key to the Species.

A^2. Prothorax very closely and roughly punctate all over in both sexes.

Black, with the vertex, a small patch on each side of the prothorax, the anterior half of the elytra and the legs yellow ♂; elytra black in the ♀, more or less broadly marginated with cinnabar.. .. .. *posticalis.*

Totally black in the male with the exception of the vertex, which is yellow .. .. var. *a.*

A^1. Prothorax finely and closely punctulate on the attenuate part and almost smooth in the posterior (♂), less sparsely punctulate in the ♀.

Black, with the palps, labrum and vertex and a lateral patch on each side of the prothorax yellow (♂), elytra cinnabar red, with a more or less broad, median black band on each side (♀) .. .. *wahlbergi.*

Body totally black, with the exception of the labrum which is flavescent .. .. var. *moerens.*

Black, with a lateral yellow patch on the prothorax; labrum, legs, and whole abdomen yellow.. .. .. var. *nigriceps.*

Pectus, anterior frontal part and antennæ black; abdomen, legs, vertex, prothorax with the exception of a median black band, yellow, the elytra from the base to past the median part cinnabar red or yellow; posterior part of elytra black ♂; ♀, elytra cinnabar red with a broad, longitudinal fuscous band; legs black .. .. .. *cardinalis.*

Body black; elytra black, with two broad transverse yellow patches, a basal one enclosing two large black patches and a post-median simple one .. .. *luteosignata.*

Eletica posticalis, Péring.,
Trans. S. Afric. Phil. Soc., iv., 1888, p. 135.

Male. Antennæ and anterior part of the frons, black; prothorax black, with a lateral rufescent yellow macule; elytra with the half anterior part yellow and the posterior black; labrum, legs and abdomen yellow, the former with the knees narrowly infuscate; under side and legs, and also the anterior part of the head, clothed with a sericeous grey pubescence, elytra glabrous; anterior part of the head deeply and closely punctate, the punctures rugose, vertex deeply canaliculated and sparingly punctate; prothorax with a deep, median grooved line, faintly impressed on each side of the disk, covered with closely set, sub-rugulose punctures from apex to base; scutellum aciculate; elytra elongated, broader at base than at apex, sinuate laterally at about the median part, very strongly coriaceous, and having on each side two costules which are carinate on the anterior part, where in addition are two short, intervening ones; upper part of anterior claws bent almost at right angles at the base.

Female. Body black, but the palps, epistome, and labrum and the sides of the head and the vertex are flavous; the lateral macule of the prothorax is less conspicuous than in the male; the elytra are fuscous black with a narrow border of cinnabar red; the head and prothorax are, if anything, slightly more closely punctate all over than in the male; the two costules on each elytron are less carinate in the anterior part and the intervening costules are not more distinctly raised than the other two; the sculpture is the same as in the male.

Var. *a*. Male. Totally black, with only the palps, the labrum and epistoma, and the apex of the head flavous.

Length 19–22 mm.; width 6½–7 mm.

Hab. Transvaal (Potchefstroom), Southern Rhodesia (Enkeldoorn).

Eletica wahlbergi, Fåhr. (♀).
Öfv. Vet. Ak. Förhandl., 1870, p. 350.

E. verticalis, Fåhr., *loc. cit.*, p. 351 (♂).

Male. Black, with the palps, the labrum and epistome, the vertex of the head, and a small lateral patch on the prothorax yellow; this lateral patch is occasionally wanting; the under side and legs are clothed with a dense appressed silky greyish pubescence, but the head is almost glabrous, the depressed anterior part of the frons is aciculate punctate, but the whole of the vertex is very sparingly punctulate and shiny; the pro-

thorax is closely aciculate in the anterior attenuate part and very briefly pubescent there, but the remainder is shiny glabrous, and very sparingly punctulate; the elytra are coriaceous with the four basal costules strongly carinate.

Female. Black, with the elytra more or less broadly marginate with cinnabar red, the colour of the head and prothorax is as in the male, but the lateral yellow patch of the latter is broader, and the punctures are more closely set in the posterior part than in the male, and sometimes less shiny.

Length 18–21 mm.; width 6¼–7 mm.

Hab. Southern Rhodesia (Matoppos, Salisbury, Enkeldoorn, Plumtree, Sebakwe).

Var. MOERENS, Péring.,

Trans. S. Afric. Phil. Soc., iv., 1888, p. 137.

Totally black in both sexes with the exception of the palps, and the apical part of the labrum. This is plainly the melanic variety of *E. wahlbergi.* The habitat is also the same.

Length 13½ mm.; width 20 mm.

Hab. Transvaal (Rustenburg); Southern Rhodesia (Mazoe, Bulawayo, Salisbury).

Var. NIGRICEPS, Péring.,

Trans. S. Afric. Phil. Soc., iv., 1888, p. 136.

Male. Similar in shape and sculpture to *E. wahlbergi,* but differs in the colouring. Black, with the palps, labrum, a plain lateral prothoracic patch, the whole abdomen and the legs flavous.

Female unknown with certainty, but I suspect it to have black legs and cinnabar red elytra with a more or less wide black longitudinal band.

Length 17–19 mm.; width 6–6½ mm.

Hab. Southern Rhodesia (Victoria Falls; Bulawayo).

Var. CARDINALIS, Péring.,

Plate XXII., figs. 5, 5*a*.

Trans. S. Afric. Phil. Soc., iv., 1888, p. 135.

Male. Pectus, antennæ, anterior part of the front black, vertex red or yellow; prothorax red or yellow, with a quadrate central black patch in the anterior part, and continued thence as a narrow band to the base; elytra yellow or cinnabar red from the base to past the median part, and black thence to the apex; abdominal segments yellow, legs yellow or red.

This variety or species differs from *E. wahlbergi,* in having the anterior part of the prothorax less finely aciculate, but the difference is very slight.

Female. Head and prothorax of the same colour as the male; the elytra are cinnabar red, with the usual broad longitudinal fuscous band, and the legs and abdomen are black.

Length 17–18 mm.; width 6–7 mm.

Hab. Southern Rhodesia (Bulawayo, Victoria Falls).

Eletica luteosignata, Fåhr.,
Öfv. Vet. Ak. Förhandl., 1870, p. 349.

Black, palps also black except the very apical part of the ultimate one, femora black with a longitudinal rufescent line along the upper side, tibiæ and tarsi rufescent; elytra with a very broad transverse pale yellow band extending from the base to one-third of the length and enclosing a juxta-sutural and a supra-lateral black patch, and a second, narrower band, situated past the middle, being almost equidistant from the centre and the apex (♂); or, prothorax with an anterior lateral triangular reddish yellow macule; elytra with a humeral yellow patch continued along the outer margin as a narrow border connecting or not with a transverse broad or narrow sinuate band reaching the suture at about one-third of the length, posterior transverse band broad or narrow sinuate or scooped; the pectus, abdomen, and legs are clothed with a dense, sericeous white pubescence; the head, especially in front, and the anterior part of the prothorax have a similar but less dense pubescence, the scutellum is very briefly pubescent, and the elytra glabrous. The head, including the vertical part, is closely punctate, and the vextex not shiny; the antennæ are shorter than in the preceding species, or varieties, and even in the ♀ barely reach beyond the median part of the prothorax, and the joints are very much less serrate; the prothorax is finely and very closely aciculate punctate in the anterior part, but with only a few very remote punctures in the posterior which is very shiny, in the manner of *E. wahlbergi*, and the sculpture of the strongly coriaceous elytra is the same.

In the female there is an apical rufo-flavescent band on the meta-sternum, and the black femora have a longitudinal streak of the same colour.

That *E. luteosignata* is not a colour variety of the preceding species is plainly shown by the shorter antennæ and the less serrate joints, and also by the sculpture of the vertical part of the head. I have seen only one example.

Length 15–28 mm.; width 5–10 mm.

Hab. Southern Rhodesia (Sebakwe, Plumtree).

Eletica stuhlmanni, Kolbe, from the Albert Nyanza region, is a very close ally of, if not identical with, Fåhrœus' species.

PRIONOTOLYTTA, n. gen.

Facies and characters of *Cantharis*, but differs in the shape of the antennal joints which are compressed and with the joints 5–10 as strongly serrate flabellate inwardly as in the genus *Eletica*.

PRIONOTOLYTTA BINOTATA, Péring.,
Trans. S. Afric. Phil. Soc., iv., 1888, p. 139.

Black, clothed with a very dense, appressed greyish pubescence hiding the black teguments, but the prothorax is yellowish red with two black macules on the central part, and the colour is not hidden by the greyish pubescence which is not so dense there as on the elytra or the under side; head with a frontal small reddish spot; abdomen reddish; head very closely aciculate and without any central frontal line; antennæ moderately long, reaching slightly beyond the shoulders, joints 4–10 triangular with the inner upper angle so acute as to give them a pectinate flabellate appearance greatly resembling that of *Eletica* but sharper inwardly, the ultimate joint is swollen in the centre and sharply acuminate; prothorax hardly broader than long, only slightly narrowed laterally at the apex, and having thus a somewhat parallel look, there is no distinct basal impression or longitudinal line, and the surface is deeply aciculate punctate; elytra elongated, attenuated from the base which is broader than the prothorax to the apex which is of about the same width, the outer margin is sinuated past the median part, the surface is finely aciculate, and there are no traces of costules; under side and legs finely aciculate.

From the appearance of the abdominal segments the only example I have as yet met with seems to be a female.

Length 8 mm.; width 2 mm.

Hab. Cape Colony (Carnarvon).

CYANEOLYTTA, gen. nov.

Mentum one-third broader than long, transversely hexagonal, ligula triangular, dilated, truncate at the upper part, deeply grooved longitudinally in the centre, the ligular lobes long, elongate ovate, densely ciliate, maxillæ robust, the lobes greatly dilated and also densely ciliate; apical joint of palps triangular; mandibles very robust, transversely curved under the labrum and not projecting slantingly beyond it, apical inner part bluntly four-dentate at tip; labrum very broad as long as the epistome, but broader; eyes very large, reniform; antennæ long, second joint small, 4–11 greatly compressed, longer than broad, dilated at apex; prothorax nearly straight laterally from the base to two-thirds of the length, moderately attenuated thence to the apex, base straight not distinctly

marginate, in the centre a longitudinal impressed line and a somewhat broad median basal impression; scutellum as broad as long, sub-ogival but somewhat rounded at apex; elytra very long, sub-parallel, but slightly ampliated at about two-thirds of the length, very little attenuated thence to the apical part, rounded at the suture and moderately divaricating there, glabrous or very briefly pubescent, the outer border plainly marginate, and the dorsal part with more or less distinct longitudinal costules; legs slender, very long; tarsi as long as or longer than the tibiæ, the joints compressed, briefly bristly underneath, claws long, greatly divaricating, cleft from apex to base; inner spur of hind tibiæ variable in shape.

The livery of the insects included in this genus is dark or light blue with a wider or lesser red patch in the centre of the metasternum. All the species are African.

In the male, the basal joint of the anterior tarsi is dilated or lobate inwardly, and the outer spur of the intermediate tibiæ dilated and laminate.

Although found on low bushes or grasses, the females are also met with going slowly along the ground somewhat in the manner of *Meloë*, to which their distended abdomen adds a touch of resemblance.

One of the South African species reaches British East Africa.

Key to the Species.

A^2. Elytra strongly coriaceous, dorsal costæ very distinct.

B^3. Basal joint of anterior tarsi of ♂ broadly dilated outwardly, but not lobate.

Neck as long as broad; inner spur of hind tibiæ extremely long, filiform in both sexes .. .. *pectoralis*.

Neck longer than broad; inner spur of all tibiæ normal in both sexes .. .. *subrugulosa*.

A^1. Elytra punctulate shagreened, dorsal costæ very faint.

B^2. Basal joint of anterior tarsi of ♂ produced into a long lobe inwardly.

Outer spur of intermediate tarsi of ♂ laminiform, obliquely truncate at apex and acuminate at tip, normal in the female; colour of upper side very dark blue or blue-black .. .. .. *subcoriacea*.

B^1. Basal joint of anterior tarsi of ♂ moderately dilated.

Outer spur of intermediate tibiæ long and slender, and basal joint of intermediate tarsi scooped inwardly from the base to the middle in the ♂.

Light blue; head with a small red macule in the ♀, not in the ♂ .. .. *signifrons*.

Dark blue; frontal part without a red macule in either sex .. var. *delagoensis*.

CYANEOLYTTA PECTORALIS, Gerst.,
Plate XXII., figs. 13, 13*a*, 13*b* (♀).
Monatsb. Akad. Wissens., 1854, p. 695.
Peter's Reis., 1862, p. 296.

Deep dark blue, turning to lighter cyaneous on the vertical part of the head, and occasionally with a slight greenish tinge on the elytra; the antennæ and tarsi are also dark blue; head and prothorax glabrous, but not so the epistome and the labrum; the head is covered all over with deep, irregular, nearly confluent punctures, in the centre of the vertex is a fine, somewhat indistinct line which disappears towards the frontal part; prothorax one-fourth longer than broad, sub-cylindrical from the base to two-thirds of the length, attenuate thence to the apex which is distinctly marginate transversely, the margin being pubescent, the base is straight, slightly marginate; in the centre is a basal impression variable in length, and through which runs a fine impressed line which either reaches the apex or not, the whole surface is covered with closely set, deep, nearly confluent coarse punctures, leaving, however, a smooth transverse area along the outer base, above this smooth area there is occasionally a faint impression on each side; scutellum briefly pubescent: elytra scrobiculate shagreened, extremely briefly pubescent, the pubescence black, the three dorsal costæ are strongly raised and reach from the base to nearly the apex, in addition to these there is a short one divaricating on each side from the inner dorsal near the base and running for about one-sixth of the length; under side and legs closely aciculate punctate, glabrous except the legs; central part of metasternum with a broadly triangular red patch. In the male the basal joint of the anterior tarsi is dilated inwardly into a sub-rectangular process hollowed laterally and filled with a spongy flavous pubescence; the intermediate and hind legs are normal in both sexes, but the inner spur of the posterior tibiæ is filiform, whitish and more than half the length of the very long basal tarsal joint. It is singular that this character should have escaped the notice of both Hagg-Rutenberg and Măklin.

Length 20–30 mm.; width 5¾–7 mm.

This so-called species is so very closely related to *C. granulipennis*, Cast., from Upper Senegal, that I doubt if it is more than a mere varietal form. In the males of both, the distinctive external sexual characters are the same, and the shape of the genital armature is alike; in both sexes the peculiar filiform shape of the inner spur of the posterior tibiæ is also absolutely identical. The sculpture of the prothorax is less closely set in the Senegal examples than in *C. pectoralis*, and the elytra are slightly more rugosely punctate shagreened. I am indebted for a co-type of *C. pectoralis* to Professor H. J. Kolbe, of the Berlin Museum.

Hab. Transvaal (Pietersburg, Barberton, Swaziland); Southern Rhodesia (Bulawayo, Salisbury, Enkeldoorn, Plumtree); Northern Damaraland, Ovampoland, Zanzibar, Bagamoyo, Somaliland.

Cyaneolytta subrugulosa, Mäkl.,

Act. Soc. Scient. Fenn., 1875, p. 456.

This species greatly resembles *C. pectoralis*, but is much inferior in size, and is at once distinguished by the normal shape of the two spurs of the hind tibiæ in both sexes. Dark blue-black or cyaneous, seemingly glabrous on the upper side, whole head scrobiculate punctate, the frontal line moderately distinct; prothorax narrower than in *C. pectoralis* and having thus the appearance of being more slender, closely punctate, the punctures somewhat deeper and slightly scrobiculate in some species, the smooth base, basal impression and median line as in the species above mentioned; elytra equally scrobiculate shagreened, and having each three very distinct costæ: under side as in the previous species.

In the male the dilatation of the inner part of the basal joint of the fore tarsi is the same as in *C. pectoralis*, and the shape of the genital clasps is closely allied.

Length 13–19½ mm.; width 5–6½ mm.

Hab. Bechuanaland (Ramoutsa); Mozambique (Lourenço-Marquez, Feira); Ovampoland.

Cyaneolytta subcoriacea, Mäkl.,

Act. Soc. Scient. Fenn., 1875, p. 457.

amabilis, Haag.-Rut., Deutsch. Entom. Zeitschr., 1880, p. 60.
affinis, Haag.-Rut., *loc. cit.*, p. 60.

Dark blue, with the elytra darker blue-black, but not uncommonly bluish green; head and prothorax glabrous; the head is of normal shape and covered with round, contiguous, smooth, somewhat small punctures; the prothorax covered with similar punctures is as broad as long, and attenuated only at a short distance from the apex, the basal median impression is deep and the base has no smooth space; elytra very briefly pubescent, finely punctate shagreened, and having on each side three fine costules; under side with the usual sculpture and vestiture; metasternal red patch very broadly triangular.

In the male the basal joint of the anterior tarsi is produced into a long, lobate process ciliate laterally, spongy underneath, and reaching the base of the second one; the outer spur of the intermediate tarsi is long, lami-

nate, curved at the base, dilated towards the apex and diagonally truncate there, the apex being very sharp. In the female the tarsi and the spurs are simple.

This species greatly resembles *C. gigas*, Fabric., from Senegambia, but differs in the sculpture of the head and prothorax, the latter being also more elongated, and in the shape of the basal joint of the anterior tarsi and of the inner spur of the intermediate tibiæ.

There can be no doubt that the Haag's and Mäklin's species are one. They vary in size and colour, but the sexual characters of the males are the same in all three.

Length 10–27 mm.; width 4–9 mm.

Hab. Transvaal (Pretoria, Pietersburg, Waterberg, Rustenburg, Middle Limpopo); Damaraland; Ovampoland; Southern Rhodesia (Plumtree, Enkeldoorn); German East Africa.

In the examples from the Transvaal the elytra have often a greenish tinge.

CYANEOLYTTA SIGNIFRONS, Fähr.,
Öfv. Vet. Ak. Förh., 1870, p. 353.

cœlestina, Haag.-Rut., Deutsch. Entom. Zeit., 1880, p. 61.

Cyaneous blue, lighter on the elytra, clothed with a very short, but dense, appressed black pubescence, legs and antennæ very dark blue; head and prothorax covered with contiguous, deep but small foveolate punctures, in the frontal part of the former is a minute red patch altogether wanting in the male; the prothorax is slightly longer than broad, moderately attenuate in the anterior part, plainly grooved in the centre from base to apex, the basal median impression is not very deep and the sides of the base are smooth; scutellum finely aciculate; elytra elongated, very little ampliated behind, closely and finely aciculate shagreened, and bearing each three very weak costules; metasternal red patch in the shape of a very broad, triangular macule in the male, and of a median longitudinal red line, often almost obliterated in the female. In the male the basal joint of the anterior tarsi is moderately dilated but not spongy underneath, and the inner part of the first joint of the tarsi of the intermediate legs is deeply emarginate inwardly from the base to the middle, and the outer spur is simple, long.

Length 17–25 mm.; width 5–7½ mm.

Hab. Cape Colony (Barkly West); Transvaal (Rustenburg); Bechuanaland (Kenya, Ramoutsa); Southern Rhodesia (Bulawayo, Salisbury, Plumtree, Enkeldoorn, Victoria Falls).

I have seen Rutenberg's type of *C. cœlestina*.

Var. DELAGOENSIS.

Smaller and blue-black, the pubescence on the upper side almost obliterated; male and female without red frontal macule; the metasternal red patch broadly triangular in both sexes; the sexual characters of the male, as well as the shape of the genital clasps, are however identical.

Length 13 mm.; width 4 mm.

Hab. Mozambique (Delagoa Bay).

PSALYDOLYTTA, n. gen.

This genus differs from *Cyaneolytta* and *Cantharis* in the extremely slender and elongated antennæ, the joints of which are almost cylindrical; the very long basal joint slightly thickened at the tip is equal in length to the third, the second, also cylindrical, is fully two-thirds of the length of the third, and the slightly tapering cylindrical ultimate joint is of the same length as the penultimate; the mentum is more than twice broader than long, and very strongly acuminate laterally in the middle, the ligula is only moderately ampliate at the anterior part, not very deeply scooped there, and the margin is set with a few setæ and two very distinct, median rigid long bristles; the labial palps are very long, the penultimate is slightly longer than the ultimate which is sub-fusiform but obtuse at apex; the maxillæ are short but robust, and the inner lobe is thickly set by curved hairs at apex, the upper is very short, but the very dense long fulvous hairs with which the edge is set are describing a broad semicircle; the head is normal, but the enormously developed mandibles are produced almost horizontally backwards from the part covered by the incised labrum; elytra cylindrical, singly rounded at apex; legs and tarsi very long, the latter villose underneath, claws very distinctly cleft into two; inner spur of hind tibiæ irregularly spatulate lanciform.

The genus is proposed for *Lytta lorigera*, Gerst., and also for the Senegambian and other species with vaulted mandibles (*flavicornis, prieuri, pilipes*, &c.). Lacordaire has already indicated (Gener. Coleopt., v., 2, 1859, p. 676) that these species, then undescribed, and also *Lytta fuscicornis*, Klug., should form a genus distinct from *Cantharis-Lytta*.

PSALYDOLYTTA LORIGERA, Gerst.,

Monatsb. Berl. Akad., 1854, p. 495; Peter's Reis., 1862, p. 295, pl. 17, fig. 10.

Dark chocolate-brown; antennæ long, slender, joints sub-cylindrical, brick-red like the palps, the labrum, and part of the epistome; mandibles very robust, the part uncovered by the labrum when closed is strongly deflexed backwards; head minutely punctate, clothed with a dense flaves-

cent pubescence either covering nearly the whole head except two elongated sub-denuded longitudinal bands on each side of the frontal part, or reduced to a median frontal line on the anterior part while the sides and the vertex are narrowly marginate; prothorax extremely closely punctulate and clothed with a pubescence similar to that of the head and leaving on each side of the median part two elongated denuded bands; this pubescence is, however, occasionally restricted to the lateral and posterior margins but always forms a conspicuous longitudinal median line or narrow band extending from base to apex; scutellum with a yellow pubescence; elytra very closely punctate, clothed with a fine, nearly appressed greyish fuscous pubescence, and having along the suture a narrow flavescent or greyish flavescent line, the outer margins have a similar band reaching from the base to the rounded part of the apex, and in the discoidal part a slightly wider band reaching from the base to a very short distance from the apical margin; under side and legs clothed with a dense, appressed, flavescent pubescence hiding the teguments; tarsi densely setose, bristly laterally.

Length 22–26 mm.; width 6–7 mm.

Hab. Mozambique (Beira); Southern Rhodesia (Umtali, Manica).

Gen. CANTHARIS, Geoffr.,
Hist. Ins. Env. Par., i., 1762, p. 339.

Lytta, Fabric., Syst. Entom., p. 260.

Epicauta, Redt., Faun. Austr., p. 631.

Mentum ampliate and somewhat angular laterally in the median part, ligula membranous, pubescent and deeply emarginate in the centre, labial palps short, the last one cylindrical and truncate at tip, but occasionally somewhat ampliate there; maxillæ elongated, moderately slender, inner and upper lobes broadly and densely penicillate, the hairs long, incurved, upper lobe very distinct from the inner, truncate at apex; ultimate joint of maxillary palps cylindrical, truncate, not longer than the two preceding ones taken together; labrum as long as a rule as the epistome, covering the robust mandibles; eyes only slightly emarginate in front; antennæ either very plainly compressed or only moderately so, long, short or very short; the basal joint is either long and slightly thickened at apex or short and strongly knobby, the second joint is always short or very short, the third comparatively long, but in the species with very short antennæ it is very small, the others are usually longer than broad, but in the species with short antennæ they are broader at apex than at base, and may be almost transverse, the ultimate joint is longer than the penultimate and acuminate at tip; prothorax variable in shape, campanulate and strongly acuminate in front or sub-quadrate; scutellum sub-parallel,

curved at apex; elytra broader than the prothorax, long, covering the abdomen, elongated in most species, converging in front or with distinct shoulders, pubescent, but occasionally glabrous, singly rounded and either plainly dehiscent at apex in which case the apical abdominal segment is not entirely covered, or not; legs long, slender; the claws of all legs are either plainly cleft or only the posterior are so divided, even in one species (*mesembryanthemi*) they are only slightly incised at the apex.

Beauregard has endeavoured to include into the genus *Cantharis-Lytta* a number of species in which, among other very secondary characters, the basal joint of the antennæ is short, clubbed at apex, the prothorax is either transverse or sub-spherical, the elytra broader than the prothorax and nearly always glabrous, and with the edges of the suture parallel. Undoubtedly some endemic South African species answer to this description, especially *nitidula, flavipennis, semilineata, lurida;* but *amoena, suaveola, spilotella, mesembryanthemi,* &c., form passages of transition between these species, which, so far as I know, have no close allies in the other parts of Africa, and those that he includes in the genus *Epicauta.* I have endeavoured in vain to divide the South African ones in sections deserving to be raised to the rank of genera, except in the case of *Cyaneolytta, Psalydolytta,* and *Prionotolytta.*

Of the South African species only two, *C. velata* and *C. strangulata,* both very closely related to Senegambian and Central African forms, reach Central Africa.

We do not possess any information regarding the life-history of our species. All those I captured exude a yellow liquid through the joints of the legs and also through the mouth. They are usually met with in the spring or after summer rains, devouring the petals of flowers. *C. pallidipennis* is usually met with on graminaceous plants, and oftener than not in the fields of oats or barley at about the same time that the young of the crickets, *Œdalus marmoratus* and *Acrotylus deustus,* make their appearance; *C. nitidula* on the dry, arid spots where *Bobardia spathæa* flowers, and where also the dry ground, sun-loving crickets, *Caloptenus hæmatopus* and *Sphingonotus,* sp., generally congregate, &c., &c.

Key to the Species.

First Division.

Elytra pubescent.

A^2. Elytra plainly divaricating from each other at apex.

B^4. Prothorax as broad as long, bell-shape, anterior part attenuate for about one-third of the length.

C^4. Antennæ very long, joints long, narrow, sub-parallel.

Fuscous black with the elytra chocolate brown, head rufescent with a median black transverse patch; antennæ less filiform, shorter and black; a median longitudinal band on the vertex and on the prothorax, a narrow line on the suture of the elytra and the outer margin, and a similarly narrow one on the median part of the disk .. var. *damarina.*

The same but without traces of the median dorsal white line on the elytra .. .. *ovampoa.*

Body black, with only a faint greyish pubescent line along the outer margin of the elytra .. .. *moesta.*

Black, clothed with a dense greyish flavescent pubescence; head rufous, with the exception of the epistome and labrum which are black .. .. *rufifrons.*

Black, clothed with a very dense sub-flavescent pubescence hiding the whole of the teguments; head rufous, epistome and labrum black .. .. *jucunda.*

B[3]. Prothorax sub-quadrate, neck very short.

Antennæ moderately long, intermediate joints not twice as long as broad.

Black, body clothed with a very dense appressed, pile-like greyish pubescence; antennæ black with the three basal joints rufescent .. .. *velata.*

The same, but the head rufescent with a broad transverse black patch .. .. *brevipennis.*

Black, clothed with a fine greyish pubescence; head rufescent with a broad, transverse black patch; elytra with a greyish line on the suture, the outer margin and the discoidal part .. .. var. *designata.*

A[1]. Elytra singly rounded at apex but not divaricating.

B[2]. Prothorax longer than broad, very strongly narrowed laterally for about one-third of the length, depressed anteriorly above and sub-gibbose in the posterior part.

C[3]. Antennæ very long, intermediate joints twice as long as broad.

Black, thorax red; elytra black at apex and base, and also with an elongated dorsal patch, the rest of the surface pale yellow.. .. .. *optata.*

Black, clothed with a very short greyish pubescence, frontal part and prothorax red; prothorax red with two black spots; tibiæ red .. .. *bisignata.*

Black, clothed with a dense appressed greyish pubescence; prothorax reddish yellow; tibiæ black .. .. *strangulata.*

Black, almost glabrous; frontal part with a broad red macule; prothorax red; head closely punctate.. .. .. *bicolor.*

Blue-black, glabrous; prothorax sub-scrobiculate punctate *mima.*

C^2. Antennæ very short, intermediate joints not compressed, very little or not longer than broad, ultimate joint acuminate as in *Mylabris*.

Testaceous-red with the anterior part of the head, the legs, and antennæ black; prothorax longer than wide, elongate ovate; head and prothorax glabrous, vaguely punctate .. .. *mesembryanthemi.*

Fuscous, densely pubescent; antennæ black; elytra flavescent and with two broad transverse fuscous bands; prothorax almost twice as long as wide, gradually narrowed from the median part to the apex.. .. .. *mashuna.*

B^1. Prothorax not longer than broad, more or less plainly attenuated laterally in the anterior part.

C^1. Antennæ moderately long.

a^2. Antennæ barely reaching the shoulders.

Black, densely pubescent, pectus, tibiæ, and upper side fleshy red; head, prothorax, and especially the elytra, maculated with fuscous .. .. *spilotella.*

Black, prothorax and elytra flavescent, the former with a median discoidal patch and two small, discoidal fuscous spots; femora flavescent; intermediate tarsal joints of forelegs triangular .. .. *elegantula.*

Fuscous black, densely greyish pubescent; head with two flavescent macules; elytra with one sutural, two dorsal, and one outer marginal yellow bands, somewhat narrow on each side .. .. *enona.*

Dark green with the elytra flavo-testaceous, clothed underneath and above with a dense pubescence; head and prothorax closely aciculate.

a^1. Antennæ reaching beyond the shoulders.

Fuscous black underneath, legs, with the exception of the basal part of the femora which is black, and upper side fleshy red; clothed with a dense greyish pubescence; prothorax maculated with fuscous in the anterior part .. .. *carneola.*

Second Division.

Elytra glabrous, very shiny.

Prothorax as broad as long, ampliated laterally in the anterior part; neck very short or absent.

Antennæ short, joints not flabellate nor serrate inwardly.

A^3. Antennæ somewhat long, reaching beyond the shoulders, joints not compressed, ultimate one acuminate as in *Mylabris*.

Under side, legs, head, and prothorax bright green; elytra pale flavescent, glabrous; head and prothorax very closely punctate, the latter with a neck .. .. *lucida*.

Under side and legs blue-black; elytra flavous or flavo-rufous, glabrous; head and prothorax deeply punctate, no neck .. .. *pallidipennis*.

A^2. Antennæ not reaching beyond the shoulders.

Under side, legs, head, and prothorax bright golden-green; elytra rufo-flavescent, glabrous .. .. *nitidula*.

A^1. Antennæ not reaching the shoulders.

Under side, legs, head, and prothorax green; elytra pale flavous with a median dorsal longitudinal blue band; head and prothorax deeply and closely punctulate; elytra pale flavous, glabrous .. *semilineata*.

CANTHARIS OVAMPOA, Péring.,
Ann. S. Afric. Mus., i., 1899, p. 319.

Var. *C. damarina*, Pér., *loc. cit.* iii., 1904, p. 286.

Closely resembling *C. lorigera* in shape and vestiture, but easily differentiated by the normal shape of the mandibles, and the much less filiform antennæ. Fuscous black, with the elytra chocolate-brown; head rufescent with a transverse, fuscous patch filling the greatest part of the frontal part and leaving above the epistome three reddish triangularly disposed patches; the three basal joints of the antennæ are rufescent; head closely punctulate, the punctures somewhat rugose, covered in part with a brief greyish pubescence more noticeable on the epistome and labrum, and along the median part of the vertex; prothorax narrowed anteriorly for about one-third of the length, closely, almost contiguously punctate, clothed with a very short, erect black pubescence, broadly marginated with greyish or greyish flavescent on the sides, narrowly so along the base, and having in the centre a conspicuous greyish or greyish flavescent longitudinal band reaching from base to apex; scutellum pubescent; elytra elongated, sub-cylindrical, finely and contiguously aciculate and having no traces of costules; on each side of the scutellum is a short transverse, ill-defined greyish band, the outer margin from the base to the apex of the rounded posterior part has a narrow greyish band, there is a similar one along the suture, and in the median part of the disk is another extending however in the central part only (*damarina*) and occasionally disappearing altogether (*ovampoa*).

In some examples of this species the claws are not plainly cleft.

Length $12\frac{1}{2}$–$17\frac{1}{2}$ mm.; width $4\frac{1}{2}$–$5\frac{1}{2}$ mm.

Hab. Ovampoland; Northern Damaraland.

Cantharis moesta, Péring.,
Trans. S. Afric. Philos. Soc., vi., 1892, p. 135.
lugubris, Pér., *loc. cit.* iv., 1888, p. 139 (nam. preoc.).

Black, with a moderately broad rufescent patch on each side of the vertex of the head behind the eye, outer margin of the elytra with a very narrow fringe of grey reaching from the humeral part to about the middle; upper and under sides clothed with an extremely short fuscous black pubescence; palps and antennæ black, the latter short, compressed, not filiform, intermediate joints slightly longer than wide, joints very briefly pubescent; head finely aciculate and with a faint longitudinal line; prothorax longer than broad, attenuate in front for about one-third of the length, having a median basal depression and a fine median line disappearing in the anterior part, the surface is as finely and closely aciculated as on the head, and so are the elytra which bear no traces of dorsal costules, and are singly broadly rounded at apex.

Length 9–10 mm.; width 3–4 mm.

Hab. Cape Colony (Kowie); Natal (Estcourt; Van Reenen's Pass); Southern Rhodesia (Salisbury).

Cantharis rufifrons, Fåhr.,
Öfv. Vet. Ak. Förh., 1870, p. 353.

Black, clothed with a greyish appressed pubescence which does not hide the colour of the background; the head, with the exception of the labrum and epistoma, is brick-red, the antennæ which are very long and with the joints sub-cylindrical have the four or five basal joints subrufescent; vertex with a distinct median line, head aciculate punctate, the punctures not very closely set; prothorax attenuated into a neck from about one-fourth of the length, longer than broad, having in the centre a hollow median line reaching from apex to base, there is no distinct median impression in the base, the surface is covered with round, slightly rugose, contiguous punctures; scutellum pubescent; elytra elongated, sub-cylindrical covered with closely set punctures similar to those on the prothorax, no traces of longitudinal costules; under side and legs finely aciculate, abdominal segments very densely pubescent; anterior tarsi of male thickly spongy underneath, the basal joint dilated.

Length 17 mm.; width $4\frac{3}{4}$ mm.

Hab. Transvaal (Rustenburg); Southern Rhodesia (Victoria Falls).

Cantharis jucunda, Péring.,
Trans. S. Afric. Phil. Soc., iv., 1888, p. 137.

Similar in shape and sculpture to *C. rufifrons* and differs only by the colour of the pubescence which is very much denser, hides completely the

teguments, and is greyish flavescent; the vertical part of the head is somewhat more densely pubescent than the anterior. The fore tarsi of the male are as in the preceding species.

Length 14–16 mm.; width 4–5 mm.

Hab. Cape Colony (Vaal River); Transvaal; Bechuanaland (Kenya, Ramoutsa); Natal (Maritzburg).

CANTHARIS VELATA, Gerst.,

Monatsb. Berl. Acad., 1854, p. 695; Peter's Reis. n. Moss., 1862, p. 296.

Black, clothed with a dense grey pubescence hiding the integuments and turning sometimes to greyish flavescent; antennæ somewhat short, black with the three basal joints rufous, intermediate joints compressed and broad, slightly wider than long; palps sub-rufescent; head and prothorax very closely aciculate, the former with a plain median line, the latter also with a median longitudinal line and no basal depression, slightly longer than broad, and narrowed towards the apex only; elytra as closely aciculate as the prothorax, without costules, and moderately divaricating singly at apex.

Length 12–16 mm.; width 4–5 mm.

Hab. Natal (Maritzburg, Durban, Eshowe); Transvaal (Pietersburg, Pretoria); Southern Rhodesia (Bulawayo); Mozambique (Feira). Ranges from Natal to Southern Somaliland.

CANTHARIS BREVIPENNIS, Haag.,

Deutsch. Entomol. Zeitschr., 1880, p. 69.

mutillata, Haag., *loc. cit.*, p. 690.

designata, Trans. S. Afric. Phil. Soc., 1892, p. 135.

Var. *albolineata*, Péring., *loc. cit.*, iv., 1888, p. 140 (nam. preoc.).

Type: In shape, sculpture and vestiture this species is almost like *C. velata;* it is black, and likewise thickly clothed with very dense greyish hairs; but the head is red with a very large fuscous patch invading almost the whole surface except for a narrow transverse band on the vertex and a very faint patch above the epistome; the three basal joints of the antennæ are weakly rufescent; the elytra are strongly divaricating at apex.

This type form seems to be restricted to certain parts of the Cape Colony (Enon, Grahamstown).

Var. *C. designata*, Péring., differs from the type form in the black patch of the head being restricted to the central frontal part only, and in the elytra having on each side a whitish grey discoidal line reaching in most cases from base to apex. In the type form the pubescence is greyish fuscous, and does not hide the integuments, the dorsal elytral

band is very distinct, and the suture and the median line of the prothorax are also narrowly banded with greyish white, but I have since seen many examples light grey above and in which the discoidal band alone was visible, although very weakly, and had even disappeared altogether.

Hab. Transvaal (Rustenburg, Lydenburg); Southern Rhodesia (Bulawayo, Enkeldoorn, Matoppos); Ovampoland.

CANTHARIS OPTATA, Péring.,
Trans. S. Afric. Philos. Soc., vi., 1892, p. 65.

Narrow, elongated; clothed with a sub-flavescent pubescence somewhat remote on the head, absent on the prothorax, very dense on the elytra; black, with the prothorax red and the elytra straw-colour and having each three black patches, the basal one rounding the shoulder and descending a little along the suture, the second one situated at about the median part of the disk is elongated, and the third one extends over the whole apical part; the antennæ are long and filiform; the head is deeply but remotely punctate and the frontal part more pubescent than the apex; the prothorax is narrowed into a long, slender neck, is deeply but remotely punctate, has a deep basal median impression, and a very short line in the centre of the disk.

Length 13 mm.; width 3 mm.

Hab. Ovampoland.

CANTHARIS BISIGNATA, Mäkl.,
Öfv. Fin. Soc., xviii., 1875, p. 83.

notaticollis, Péring., Trans. S. Afric. Phil. Soc., iv., 1888, p. 138.

Black, head with a broad frontal patch extending from the epistome to the vertex; prothorax red with two small black patches in the anterior part, tibiæ reddish; antennæ long, somewhat slender, the intermediate joints more than twice longer than broad, and not much compressed; head and prothorax glabrous or nearly so, the former is somewhat closely and deeply punctured, the punctures are more remote on the prothorax which is strongly attenuated into a neck from about the median part, and has a deep, broad basal impression and a short line in the centre; elytra very finely aciculate shagreened, clothed with a very short, appressed greyish flavescent pubescence which does not however hide the colour of the background; they are only moderately divaricating at apex, and have each a very faint trace of two dorsal costules.

Length 17–19½ mm.; width 5¾–6½ mm.

Hab. Transvaal (Pretoria, Rustenburg, Pietersburg); Cape Colony (Kimberley, Vryburg); Ovampoland.

Cantharis strangulata, Gerst.,
Monatsb. Akad. Wiss. Berl., 1854, p. 695.
Peter's Reis. n. Moss., 1862, p. 295.

fulvicornis, Fähr., Öfv. Vet. Ak. Förhdl., 1870, p. 353.

Black, with a very faint blue black metallic tinge more distinct on the under side than on the upper; prothorax and pedicel of head reddish yellow; antennal joints past the three basal ones fuscous rufescent; head clothed with a brief somewhat dense greyish pubescence and sub-remotely punctulate, but the punctures are more closely set on the vertex, above the epistome is a very plain, arcuate impression; antennæ long slender, joints sub-cylindrical, and with the exception of the basal three, almost three times as long as broad; prothorax twice as long as broad, and narrowed in front into a long neck, glabrous, and bearing a few greatly remote, shallow punctures; elytra very elongated, cylindrical, not much divaricating singly at apex, very closely punctulate sub-shagreened, each puncture bearing a long, appressed greyish hair forming however only a spare pubescence, there are no traces of dorsal costules; legs and under side as pubescent as the elytra.

Length 13–17 mm.; width 3½–4 mm.

Hab. Cape Colony (Kimberley, Colesberg, Vaal River, Enon); Transvaal (Rustenburg, Pietersburg, Waterberg, Pretoria).

This species occurs also in Zanzibar. Owing to the courtesy of Professor H. J. Kolbe, of the Berlin Museum, I have been able to examine a co-type of Gerstäcker's species.

Cantharis bohemani, Mäkl.,
Öfv. Fin. Soc., xviii., 1875, p. 83.

bicolor, Fähr., Öfv. Vet. Ak. Förh., 1870, p. 353.

Black, sub-opaque, upper part of prothorax red, head with a very distinct median frontal red macule; head very briefly pubescent, and very closely and somewhat deeply punctate all over; antennæ long, joints sub-cylindrical, somewhat compressed; prothorax very strongly narrowed laterally into a long neck from about the median part, the anterior part is also strongly depressed above, the posterior being thus almost gibbose, the base is fossulate in the centre, there is a central line from the fossule to the median part, and the surface is remotely punctate, each puncture bearing a minute black bristle; elytra elongated, coriaceous shagreened, very briefly pubescent, and the pubescence fuscous, they have no trace of costules; the under side and legs are very closely aciculate punctate, and clothed with a very brief pubescence.

Length 23 mm.; width 6 mm.

Hab. Cape Colony (Colesberg), Transvaal (Pietersburg), Southern Rhodesia (Salisbury).

CANTHARIS MIMA, n. sp.

Head, antennæ, prothorax and legs black; elytra, pectus and abdomen blue-black; antennæ long, joints sub-cylindrical but slightly compressed; head briefly pubescent and, like the prothorax, shining, and closely and deeply punctate all over; prothorax very strongly narrowed laterally into a long neck from about the median part, transversely depressed above in the anterior part, sub-gibbose in the posterior, fossulate in the centre of the base and with a short but deep median line, broadly and deeply punctate, the fossule-like punctures sub-contiguous and each bearing a very short bristle; elytra elongated coriaceous, clothed with a fuscous greyish appressed pubescence; under side deeply and closely punctulate, briefly pubescent.

In colour, this species greatly resembles the dark blue species of the genus *Cyaneolytta*, but is at once distinguished by the shape of the prothorax, the absence of a red pectoral macule, and the normal shape of the tarsi and spurs.

Length 14 mm.; width 4 mm.

Hab. Northern Damaraland.

CANTHARIS MESEMBRYANTHEMI, Péring.,
Trans. S. Afric. Phil. Soc., iv., 1888, p. 140.

Brick-red, with the labrum and epistome, the antennæ, legs and pectus fuscous rufescent; upper side almost glabrous, except on the epistome, and shiny, under side sparingly and very briefly pubescent; legs pubescent; head with two plain impressions at the base of the frontal part, the whole of it is very sparingly and very remotely punctate, the punctures on the labrum and epistome are however deeper and much more deeply set; antennæ very short, not reaching the shoulders, the six penultimate joints are nearly as broad as long; the pedicel of the head is fuscous; prothorax longer than broad, gradually attenuate rounded laterally from the median part to the apex, without being constricted there, the median basal fossule is elongated, and the anterior part of the prothorax is plainly sloping, but not transversely impressed, and the surface is very sparingly and very remotely punctate; elytra strongly coriaceous, elongated, slightly ampliate behind, plainly singly rounded at apex, but not divaricating, and with the posterior margin somewhat broadly edged with black, the dorsal costules are not strong, but they are discernible; the under side, abdomen and legs are closely aciculate; anterior tarsi shorter than in any other South African species, from which this species differs also by the elongate-ovate prothorax. Only the claws of the hind legs are slightly cleft at the tip in the three examples which I examined.

Length 10–11 mm.; width 3 mm.

Hab. Cape Colony (Namaqualand, in the flowers of the numerous Mesembryanthemums; Hopetown).

CANTHARIS MASHUNA, Péring.,
Ann. S. Afric. Mus., i., 1899, p. 318.

Black, with the elytra light tawny flavescent, and having on each side a very broad fuscous band beginning near the basal part and reaching slightly past the median part, but not quite reaching the suture or the outer margin, and a post-median narrower yet broad band somewhat connected near the suture with the anterior band; both the upper and under sides are clothed with a very short yet dense sub-flavescent pubescence, not thick enough however to hide the teguments; head closely and finely aciculate punctate, the punctures somewhat closely set; antennæ short, and probably hardly reaching the shoulders—the antennæ of the only example I saw are mutilated, there being only 8 joints left, but the missing ones could not have been much elongated—joints 5 to 8 in the shape of an upturned transverse cone the base of which would be equal to the length; prothorax almost twice as long as broad, moderately narrowed in the anterior part for about one-fourth of the length, very plainly grooved in the median part and without any basal median impression, very closely aciculate punctate; elytra very closely aciculate and having on each side faint traces of two costules in the anterior part only; under side very closely aciculate; legs and tarsi very densely pubescent.

Length 9 mm.; width 3 mm.

Hab. Southern Rhodesia (Enkeldoorn).

CANTHARIS SPILOTELLA, Péring.,
Ann. S. Afric. Mus., iii., 1904, p. 286.

Fuscous black, with the frontal part of the head, a broad discoidal patch on the prothorax, a large patch on the metasternum, and the femora and tibia, with the exception of the apices which are infuscate, reddish with a fleshy tinge; elytra testaceous and sprinkled all over with irregular black spots; the whole body is covered with an appressed greyish white pubescence; head foveate-punctate, the palpi, labrum and epistome are black, and there is a frontal median black stripe reaching to about half the length of the frontal part showing a longitudinal raised area in relief; prothorax slightly longer than broad, strongly attenuate in the anterior part for about one-half of the length, grooved longitudinally from the base which is not impressed, to a short distance from the apex, irregularly and deeply punctate, and having on each side a smooth, median areolet, and another one somewhat less defined near the base; elytra elongated, sinuate

laterally and slightly ampliated in the posterior part, singly rounded at apex but not divaricating, and having on each, in the dorsal part, three plain costules and another less well-defined running parallel with the somewhat deplanate outer margin for the greater part of the length; they are coriaceous shagreened, and the appressed pubescence hides the background except the black spots which are glabrous; antennæ black, short, barely reaching the humeral part, joints 4–10, in the shape of a broadly truncate cone, or nearly as broad as long.

Length 14 mm.; width 5½ mm.

Hab. Transvaal (Waterberg).

Cantharis elegantula, n. sp.

Black, with the thorax flavescent and bearing a small fuscous patch in the centre of the disk, and a small fuscous dot equi-distant from the centre and the base on each side, elytra fulvous flavescent, femora except the knees flavous; head, under side and legs clothed with a short appressed silky whitish pubescence, this pubescence on the elytra is extremely short; head finely and very closely aciculate, antennæ reaching slightly beyond the humeral part, joints 3–10 triangular, apical one somewhat swollen in the centre; prothorax weakly and remotely aciculate punctate, gradually ampliate laterally, but broader by one-third at the base than at the apex, deeply grooved in the centre from end to end and with a narrow, broadly triangular impression along the base, and a deeper transverse one in the anterior part; scutellum weakly grooved in the centre, and sub-pilose; elytra elongated, the apices not singly rounded at apex, minutely punctulate, sub-coriaceous, each puncture bearing a diminutive hair; under side closely aciculate: the three median joints of the tarsi of the fore and intermediate legs are triangular, the inner part of the basal joint of the posterior ones is produced into a very plain spine (♂).

Length 10 mm.; width 3 mm.

Hab. Cape Colony (Clanwilliam).

Cantharis enona, Péring.,
Ann. S. Afric. Mus., vol. i., 1899, p. 318.

Black, clothed with an appressed greyish flavescent pubescence, frontal part with a flavescent patch on each side, elytra with the suture, two dorsal yellow bands on each side, and the outer margin flavous; antennæ short, barely reaching the humeral part, joints, with the exception of the three basal ones, sub-conical, or nearly as broad as long; head scrobiculate punctate in the frontal part, and fossulate on the vertex, the punctures contiguous, in the centre a short, impressed longitudinal line; prothorax

slightly longer than broad, narrowed laterally in the anterior part for about one-third of the length, slightly ampliated in the centre, deeply but narrowly grooved in the centre from the base, which is not impressed, to about two-thirds of the length, and scrobiculate-punctate as on the frontal part; elytra cylindrical, strongly shagreened and with the two dorsal bands on each side distinctly costulate, between the suture and the first discoidal band is another very fine costule which disappears beyond the median part; under side aciculate punctate, deeply pubescent; anterior tibiæ somewhat ampliated inwardly towards the apex.

Length 15 mm.; width 5¼ mm.

Hab. Cape Colony (Uitenhage).

CANTHARIS CARNEOLA, Péring.,
Trans. S. Afric. Phil. Soc., vi., 1892, p. 125.

Of a fleshy colour, but the under side with the exception of the two apical abdominal segments, the antennæ, palps and base of femora black, prothorax edged all round with black, more broadly along the anterior than along the posterior margin, and bearing also an ill-defined fuscous macule on each side, the whole body is clothed with a silky flavescent appressed pubescence; the whole head is very closely aciculate punctate, without any frontal line; prothorax ampliate rounded laterally in the centre and not produced into a neck, there is no basal depression nor traces of a longitudinal line, and the whole surface is very closely aciculate; elytra cylindrical, somewhat robust, little ampliate behind, narrowly rounded singly at apex, not costulate, and very finely aciculate punctate; antennæ reaching beyond the humeral parts, joints 5–10 longer than broad, of an inverted cone shape; hind femora thickened (♂).

Length 13 mm.; width 5 mm.

Hab. Cape Colony (Namaqualand).

CANTHARIS AMOENA, Péring.,
Trans. S. Afric. Phil. Soc., vi., 1892, p. 126.

Dark green, with the antennæ black and the elytra flavescent rufescent, under and upper sides clothed with a dense appressed greyish pubescence; antennæ very short, not reaching the humeral part, joints almost quadrate; head closely aciculate, and having a not very distinct, small smooth patch on the anterior part of the frons; prothorax of the same shape as that of *C. semilineata*, and very closely punctulate, the central part is more or less distinctly furrowed longitudinally; elytra elongated, sub-cylindrical, punctate shagreened, briefly but very densely pubescent, and without any

traces of dorsal costules; under side closely aciculate; anterior tarsi moderately long.

Length 7½–8 mm.; width 3 mm.

Hab. Cape Colony (Namaqualand).

Cantharis lucida, Haag-Rut.,
Deutsch. Entom. Zeit., xxiv., 1880, p. 65.

Bright emerald-green, elytra bright straw-colour, antennæ and palpi black, tarsi cyaneous; clothed except on the elytra which are glabrous, with a fine, greyish flavescent pubescence, only moderately dense, and erect on the head and prothorax; antennæ long, reaching beyond the shoulders, joints nearly twice as long as broad, slightly compressed; head and prothorax deeply and closely punctate, the former has a frontal impression and a deeply impressed line from there to the epistome; prothorax slightly longer than broad, very slightly wider in the centre than at the base, attenuated gradually from near the central part to the apex which is half the width of the base, in the centre of the disk is an elongated ovate impression and none at the base; elytra elongated, sub-cylindrical, only moderately singly rounded at apex, weakly coriaceous, and each with a very slight, often indistinct discoidal longitudinal raised line; under side and legs closely aciculate; outer spur of hind tibiæ thickened, truncate at tip.

Length 11–15 mm.; width 4–5 mm.

Hab. Cape Colony (Cape Town, Stellenbosch, Paarl, Ceres, Worcester, Knysna).

Cantharis pallidipennis, Haag-Rut.,
Plate XXII., figs. 14, 14*a*, 14*b*.
Deutsch. Entomol. Zeitschr., 1880, p. 66.

Very dark cyaneous, antennæ and palps black; elytra flavescent red glabrous, the other parts of the body clothed with a fuscous pubescence; antennæ reaching the shoulders but not beyond it, joints slightly attenuate at the base, about twice as long as broad at apex; head deeply and closely pitted and having a short, frontal, weakly impressed line; prothorax distinctly broader at a short distance from the apex than at the base, deeply and closely punctate, and having in the centre a short deeply impressed line, and occasionally a narrow, elongated impression; elytra elongated, sub-cylindrical, sub-coriaceous and with fine irregularly disposed and remote punctures, on each side are two plain discoidal costules, and occasionally a third supra-marginal one is discernible; under side and legs

very closely aciculate; outer spur of hind tibia long and as sharp as the inner one.

Length 14–22 mm.; width 4½–7 mm.

Hab. Cape Colony (Cape Town, Stellenbosch, Paarl, Malmesbury).

CANTHARIS NITIDULA, Fabric.,
Plate XXII., figs. 6, 6*a*.
Syst. Entom. Append., p. 820.

Green, briefly pubescent, with often a golden tinge on the prothorax, elytra glabrous, testaceous with a fleshy tinge; palps and antennæ black, the latter do not reach beyond the shoulders, and the short joints, which are sub-turbinate, are as broad at the top as long; head very sparsely punctulate and having a long frontal impressed line reaching from the top of the vertex, which is slightly fossulate, to the epistome; prothorax very sparsely pubescent, ampliate rounded laterally at a very short distance from the apex and sinuate above the basal part, it is sparsely punctulate like the head and has in the centre a longitudinally elongated, very plain impression; elytra elongated, sub-cylindrical, moderately singly rounded at apex, sub-coriaceous but not punctulate, and having no traces of dorsal costules; under side finely aciculate; anterior tarsal joints short, sub-turbinate, intermediate and posterior little elongated; inner spur of hind tibiæ long and as sharp as the inner at tip.

Length 13–18 mm.; width 4–5½ mm.

Hab. Cape Colony (Cape Town, Stellenbosch, Paarl, Riversdale, Caledon).

CANTHARIS SEMILINEATA, Haag-Rut.,
Berl. Ent. Zeitschr., 1880, p. 67.

mera, Péring., Ann. S. Afric. Mus., i., 1899, p. 318.

Dark metallic blue turning to dark green on the head and prothorax, elytra pale yellow with a dark fuscous, moderately broad discoidal band reaching from near the base to a short distance from the apex, and with the suture and the outer, but not the posterior, margin very narrowly edged with fuscous; under side, head and prothorax clothed with a long, not appressed greyish and black pubescence; elytra glabrous; antennæ short not reaching quite the humeral part, joints slightly longer than wide, not compressed, ultimate one very acuminate at the tip; head covered with deep contiguous punctures, and having on the frontal part, above the epistome, a moderately deep impression, epistome and labrum dark blue; prothorax as broad as long, hardly attenuate in the anterior part and slightly ampliate there laterally, in the centre of the disk is a very

distinct impression, the surface is covered with punctures similar to those of the head, and equally closely set; scutellum pubescent; elytra glabrous except for a few setulose hairs on the sides of the shoulders, and a fringe of setæ along the outer margin, very finely aciculate but not coriaceous, and without any visible traces of dorsal costules; under side and legs closely aciculate punctate; anterior tarsi long; spurs of hind tibiæ both very short, but sharp.

Length 8–9 mm.; width 3½ mm.

Hab. Cape Colony (Clanwilliam).

GEN. SITARIS, Latr.,
Plate XXII., fig. 9.
Hist. Nat. Crust. and Insect., x., p. 402.

Mentum long, somewhat narrow, ligula very deeply incised in the centre, almost bi-lobate on that account, labial palpi short, the palpigers very long; maxillæ not very robust, inner lobe narrow, upper dilated, hairy; maxillary palps of moderate length, the last joint very little longer than broad, occasionally fused with the penultimate, sub-truncate at tip; mandibles robust, strongly falciform, the right one sinuate inwardly, and sharp; labrum transverse, short, epistome reaching beyond the insertion of the antennæ; head deflexed, sub-vertical, broadening on the vertex, neck somewhat long, eyes large, not very broad, but long; antennæ with the first joint knobby, the second small or very small, the third as long as the two preceding ones taken together, in the ♂, the following joints are nearly equal in length to the third, not compressed but not cylindrical; in the ♀ they are distinctly shorter, and only half the length of the third; prothorax transverse, sub-quadrate, depressed; scutellum very broad, and very long, rounded at apex; elytra considerably broader at the base than the prothorax with the shoulders rounded, very deeply sinuate outwardly at about one-third of the length, the inner part strongly divaricating at or near the scutellary region and strongly attenuated thence to the apex, leaving the greatest part of the abdominal segments covered by the wings only; metasternum strongly developed; legs somewhat short, the hind femora more robust than the others, outer spurs of the posterior tibiæ thick, dilated at tip, more so in the ♀ than in the ♂, scooped inwardly and either sub-truncate or acuminate outwardly at apex, claws broadly divaricating, upper part pectinate, lower filiform.

This genus is easily distinguished from its congeners by the broadly divaricating elytra, which are gradually attenuated in the inner part from near the scutellary region down to the apex.

Two species, very distinct from each other, are recorded from the South African area.

SITARIS CAPENSIS, Péring.,
Trans. S. Afric. Phil. Soc., iv., 1886, p. 141.

Testaceous red, moderately shiny; elytra punctulate, yellowish with the median part of the suture, the outer margin from some distance from the base to the apex, where it broadens considerably, and a humeral narrow band obliquely directed towards the median dorsal part infuscate; antennæ with the exception of the two basal joints which are red, knees, hind tibiæ and tarsi fuscous black; body densely pubescent, especially the under part. Head deflexed, rugose, and with a deep impression in the centre; prothorax slightly broader than long, slightly ampliated laterally towards the median part, very little narrower at apex than at base, deeply impressed transversely on the median part of the disk, and with a shallow median impression above the centre of the base; it is sparsely punctate; scutellum punctate and pubescent, deeply impressed in the centre of the base; elytra broader than the prothorax and three times as long, with the humeral angles very prominent, slightly sinuate laterally in the middle and greatly diverging at the suture from the median part to the apex, which is reduced to one-fourth of the width of the base; they are finely rugose and very briefly pubescent, and have each one discoidal longitudinal raised line; under side finely aciculate punctate, the meso- and metasternum are marginated with black.

Length 12 mm.; lat. $4\frac{1}{2}$ mm.

I found my first example of this species close to the nest of a bee belonging to the genus *Anthophora*.

Hab. Cape Colony (Malmesbury).

SITARIS NOTATICOLLIS, Péring.,
Trans. S. Afric. Philos. Soc., iv., 1886, p. 141.
Plate XXII., fig. 9.

Black, with the prothorax, elytra, and abdomen light yellow; prothorax with two black macules on the disk, apex of elytra black; body covered with a flavescent pubescence short on the prothorax and elytra, longer on the head and especially denser on the under part of the body and on the legs. Head very rugose, separated from the epistome by a transverse impression, in the centre of the vertex is a shiny patch; antennæ black, the joints moderately robust, not compressed yet not cylindrical; prothorax as broad as long with the base and apex nearly equal in width, somewhat ampliated laterally in the anterior part; deeply bi-impressed longitudinally in the centre, and also deeply but irregularly and not very closely punctate; scutellum black, scabrose punctate, apex smooth, shiny; elytra divaricating inwardly from the scutellary region to the apex where they are singly sharply acuminate, and very deeply

sinuosely emarginate from a third of the length; they are finely coriaceous, and have no distinct traces of discoidal raised lines; under side closely aciculate punctate.

Length 7–9 mm.; width 3–3½ mm.

Cape Colony (Grahamstown).

Tribe ZONITINI.

Key to the Genera.

A^2. Prothorax strongly campanulate.

B^2. Upper part of the claws pectinate.

Maxillæ moderately robust, upper lobe short; body glabrous, eyes lateral .. .. *Zonitomorpha.*

Maxillæ slender, upper lobe long, penicillate, body briefly pubescent, eyes sub-contiguous beneath .. .. *Zonitoschema.*

B^1. Upper part of the claws not pectinate.

Maxillæ very slender, upper one with a long pencil of hairs; body densely pubescent; eyes lateral, elongated .. .. .. *Iselma.*

A^1. Prothorax transverse or only slightly campanulate.

B. Upper part of the claws pectinate.

Head produced into a long triangle; upper lobe of maxillæ very long, corneous, briefly hairy inwardly only, but ending in a fine pencil of hairs .. .. *Zonitodema.*

Head produced into a short triangle; upper lobe developed into a very long filiform process the whole surface of which is covered with short hairs .. .. *Nemognatha.*

ZONITOMORPHA, n. gen.

Plate XXII., fig. 7*a*.

Mentum hexagonal, as broad as long, ligula very short with the membrane lining it very long, deeply-scooped V-shape in the centre and fringed there with a short, erect pubescence; labial palps moderately long, the ultimate joint truncate at the tip; maxillæ somewhat robust, the inner lobe densely hairy, the upper one densely penicillate, some of the hairs are stiff and bristle-like; maxillary palps like the labial, distinctly long; mandibles very long, arcuate and sharp at tip, projecting much beyond the labrum which is truncate at apex, as long as the epistome, and ciliate pubescent at the tip; head much longer than broad, truncate behind, with the posterior angles well defined and provided with a long neck; eyes reniform but broadly separated on the upper and on the under sides; antennæ

long, reaching to about the median part of the elytra, compressed, serrate inwardly except the two basal and the apical one; prothorax tapering gradually from the base to the apex where it is less than half the width of the latter which is marginate; scutellum very broadly triangular, obtusely truncate at apex; elytra one-third broader than the base of the prothorax, rounded at the shoulders, elongated, sinuate laterally at about one-third of the length, somewhat ampliate past the sinuation, rounded at apex and not divaricating there, moderately convex; legs and tarsi only moderately slender, spurs of tibiæ somewhat short and of nearly the same size, claws long, greatly divaricating, the upper part weakly pectinate, the lower equally long but very slender, almost filiform.

The facies is not unlike that of *Stenodera*, but it differs by the shape of the antennæ.

Key to the Species.

A^2. Elytra somewhat ampliated past the middle.

B^2. Prothorax punctate, the punctures deep, nearly contiguous.

Elytra with a broad transverse median black band .. .. *sellata.*

A^1. Elytra not distinctly ampliated past the middle.

B^1. Prothorax with shallow punctures.

Elytra without transverse median black band .. .. *transgressor.*

Zonitomorpha sellata, Fåhr.,
Öfv. Vet. Akad. Förhandl., 1870, p. 354.

Very briefly pubescent, yet shiny; testaceous yellow with the mandibles at apex, the palps, the antennæ, a broad transverse band situated slightly in front of the median part and reaching from side to side, and the sternum black; the femora are fuscous at base and apex, so are the knees and the apex of the tibiæ; the tarsi are wholly fuscous; head very closely and somewhat deeply punctate, but less so in the middle of the vertex; prothorax longer than broad, attenuate towards the apex where it is only half as wide as the base, slightly sinuate laterally towards the middle, moderately convex on the posterior part, depressed on each side of the anterior part, closely but not sub-contiguously punctate, very faintly canaliculated longitudinally and having a more distinct impression in the centre above the base; scutellum slightly infuscate; elytra slightly sinuate towards the median part, somewhat ampliate thence, very little attenuate towards the apex, rounded there, the posterior part plainly convex, deeply and irregularly punctate, almost shagreened on the transverse black band, the punctures closely set; under side finely aciculate punctate; antennæ reaching beyond the median part of the elytra, opaque

except the two basal joints which are shiny, and have occasionally the first joint rufescent, the intermediate compressed joints, which are twice as long as broad or more, are strongly angular inwardly at tip.

I have seen examples in which the transverse black band of the elytra is entirely wanting.

Length 8–12½ mm.; width 2–4 mm.

Hab. Natal (Durban, Maritzburg); Transvaal (Pretoria, Waterberg, Zoutpansberg); Southern Rhodesia (Salisbury).

Zonitomorpha transgressor, Péring.,
Ann. S. Afric. Mus., i., 1899, p. 319.

Very briefly pubescent, yet shiny; palps, antennæ, with the exception of the two basal joints which are yellow rufescent, meso- and metasternum, apex of femora and tibiæ, and the whole tarsi black; head closely and deeply punctate, parallel, slightly longer than broad, sinuate towards the middle with the posterior angles straight and prominent, antennæ reaching the median part of the elytra, compressed, the joints broad, distinctly angular inwardly; prothorax truncate at each end, somewhat conical, broader at the base than at the apex by one-third, closely punctulate, very briefly pubescent, and having in the centre an elongated longitudinal impression which does not reach either the apex or the base; scutellum closely punctulate. rounded at apex; elytra oblong, double the width of the prothorax in the anterior part, three times as long, slightly sinuate behind the humeral part, not distinctly ampliate laterally past the middle, jointly rounded at apex, moderately convex on the upper side, closely and deeply punctate, but less deeply so in the posterior part, and having on each side three distinct costules reaching from the base to the apex; under side of the body briefly greyish pubescent; legs somewhat long, finely punctulate.

Length 14 mm.; width 5¼ mm.

Resembles a little examples of *Z. sellata* without transverse black band on the elytra, but the antennæ are somewhat shorter, and the joints wider.

Hab. Southern Rhodesia (Bulawayo).

ZONITOSCHEMA, n. gen.,
Plate XXII., fig. 8*a*.

Closely allied to *Zonitomorpha*, but differs in the shape of the maxillæ which are narrower and more elongated, and bear at apex a longer pencil of hairs; the eyes, which are more granular, are less broadly separated on the upper side, and are sub-contiguous on the under side; the antennæ are very long and very slender, the intermediate joints being slightly

arcuate; the elytra are cylindrical; the legs are somewhat more slender; the upper part of the claw is also pectinate and the lower filiform.

Differentiated from *Zonitomorpha* by the greater development of the eyes above and their sub-contiguity beneath, as well as by the shape of the antennæ.

Key to the Species.

A^2. Elytra without black markings.

B^2. Prothorax very narrowly attenuate in front.

Head and prothorax pale flavescent; elytra fleshy pink .. .. *coccinea.*

Head and prothorax pale flavescent, elytra pale straw-colour, with a narrow basal and apical pink border .. .. var. *pulchella.*

Head and prothorax pale flavescent; elytra entirely very pale straw-colour .. .. *eborina.*

B^1. Prothorax less narrowly attenuate in front .. .. *saga.*

A^1. Elytra with a black band.

Pale yellow on the upper side, elytra black from past the middle to the apex; under side antennæ and legs black .. .. *posticalis.**

ZONITOSCHEMA COCCINEA, Fabr.,

Plate XXII., fig. 8.

System. Eleuth., ii., p. 77; Fairm., Ann. Soc. Ent. Fr., 1891, p. 264.

suaveola, Péring., Ann. S. Afric. Mus., i., 1899, p. 320.

Pale flavous, with the elytra pink or fleshy pink, antennæ deep fuscous with the exception of the first joint which is flavous, apex of mandibles, knees, tibiæ and tarsi fuscous black; body extremely briefly pubescent on the upper and under sides; head deeply and somewhat closely punctate all over, the labrum less so, shiny; prothorax also shiny and with the punctures nearly similar to those on the head but a little more closely set; it is longer than broad, attenuate laterally from near the median part to the apex, and nearly linear from the median to the base, only moderately convex from the middle to the transversely carinate base over the centre of which is a shallow depression; scutellum closely punctulate; elytra finely aciculate punctate with the punctures contiguous, cylindrical, and having on each side two very fine not always distinct dorsal longitudinal raised lines; under side and legs very finely and closely

* *Zonitis tenuicollis*, Fabric., which Kolbe mentions as occurring also in Natal ("Die Kaf. Deutsch. Ost.-Afrikas," p. 262), is unknown to me. It may, however, be identical with one of the species here described, in which case it will have to be included in this genus.

aciculate punctate and clothed with a slightly longer pubescence. The antennæ are as long as the whole body.

Length 11½ mm.; width 3 mm.

Hab. Southern Rhodesia (Mazoë).

I am not certain that my examples are Fabricius' *Lytta coccinea*, in which case the name *suaveola* will be retained.

Var. PULCHELLA, Pér.,

Trans. S. Afric. Philos. Soc., vi., 1892, p. 126.

Similar to the type form from which it differs in the coloration of the elytra, which are very pale flavescent with a somewhat narrow red band along the base, and a narrower one along the apical margin.

Length 13 mm.; width 4 mm.

Hab. Natal (Durban); Cape Colony (Port St. John).

ZONITOSCHEMA EBORINA, Fähr.,

Ofv. Vet. Akad. Förhandl., 1870, p. 354.

Shape of the preceding species. The vestiture is also the same, but the head and prothorax are more finely and somewhat more closely punctulate, but the punctuation of the elytra is however the same as in *Z. coccinea;* the head and prothorax have a flavescent tinge, and the elytra are very pale flavescent, almost flavescent white, without any trace of narrow red border at the base or at the apex; antennæ not quite as long as the body but nearly so, black with the basal joint flavescent; palps, knees, tibiæ, and tarsi black.

Length 9–12½ mm.; width 2¾–4 mm.

Hab. Cape Colony (Uitenhage); Natal (Durban); Transvaal (Rustenburg).

ZONITOSCHEMA SAGA, Péring.,

Ann. S. Afric. Mus., i., 1899, p. 320.

This species is so closely allied to *Z. eborina* that I took it at first to be identical. It is however distinguished by the still briefer pubescence of the elytra, and especially by the shape of the prothorax which is less acuminate at apex than that of *Z. eborina.* I have however seen as yet one example only of this species.

Length 14 mm.; width 4½ mm.

Hab. Cape Colony (Worcester Distr.).

ZONITOSCHEMA POSTICALIS, Péring.,
Trans. S. Afric. Phil. Soc., vi., 1892, p. 135.
apicalis, Pér. (nam. preoc.), *loc. cit.*, iv., 1886, p. 142.

Body clothed with a very short flavescent pubescence; head, prothorax, elytra from the base to two-thirds of the length yellow, the remainder of the latter black; under side except the two apical abdominal segments which are yellow, palps and legs black; all antennal joints, the labrum and mandibles fuscous black; head deeply punctate, especially in the frontal part, the punctures not set very close and leaving in the centre of the forehead a narrow longitudinal smooth space; prothorax strongly attenuate in the anterior part for about one-third of the length, slightly yet distinctly sinuate thence towards the base which is broader than the median part, covered with moderately shallow punctures separated by an interval nearly equal to their own diameter, narrowly impressed longitudinally in the centre, and transversely along the carinate base; scutellum closely punctate; elytra impressed laterally at the base above the shoulder, straight, not distinctly sinuate laterally, not much convex, and covered with somewhat deep punctures separated by a very narrow interval; the suture is slightly raised and there are on each side two slightly raised lines which disappear in the posterior part; under side and legs very closely aciculate punctate, and more densely pubescent than on the upper side.

Length 20½ mm.; width 5 mm.

Hab. I am not sure that this insect is a native of South Africa. It was given to me long ago, and I did not record the locality at the time, perhaps because it was not indicated.

GEN. ISELMA, Haag-Rut.,
Plate XXII., fig. 11*a*.
Deutsch. Entom. Zeitsch., xxiii., 1879, p. 402.

Mentum longer than broad, sub-ovoid laterally, the ligular part is completely fused with the mentum, very strongly attenuate, parallel, nearly half the length of the mentum proper, slightly emarginate at apex and translucid; the labial palps are set close together on the outer face and separated by a narrow, sub-carinate process bearing two stiff setulose bristles, outer face of the mentum deeply pitted, slightly impressed in the centre; labial palps of normal length, the joints nearly equal in length, sub-cylindrical, ultimate one truncate; maxillæ very long and slender, inner lobe with the suture almost obliterated and weakly pubescent, upper lobe sub-cylindrical, lined inwardly and at the top with a very long pubescence; maxillary palps very long, sub-compressed, ultimate one truncate at tip; head greatly elongated and narrow, as long

as the prothorax and provided with a long neck, parallel from the vertex to the epistome, the eyes ovate, not reniform, epistome shorter than the labrum which is slightly attenuate, mandibles very long, slightly tapering and hooked at tip; antennæ very long, slender, joints sub-cylindrical, occasionally angular inwardly at tip, ultimate joint longer than the penultimate; prothorax longer or as long as broad, strongly tapering in the anterior part, ovate globose in the posterior; scutellum long, oblong; elytra broader than the prothorax, elongated, sub-cylindrical, but occasionally plane on the dorsal part (*planidorsis*), not singly rounded at apex, without costules, always pubescent; last abdominal segment of ♂ deeply scooped; legs long, tarsi also long, bristly laterally, claws corneous, each one very deeply cleft as in *Cantharis*, and likewise not pectinate; spurs of hind tibiæ either contiguous or not at the base, equally long or the inner one longer, sometimes one or both are sub-spatulate or truncate diagonally and sharp at apex.

The species included in this genus have not been recorded from beyond the South African limit. They are mostly found in the western part of the Cape Colony, but one species is recorded from the eastern provinces. They are floricolous, and appear for a short time only. Nothing is known of their habits.

Key to the Species.

A^2. Elytra sub-cylindrical.

B^3. Hind spurs not connected at the base, of nearly equal length and not ampliate at apex.

Black, clothed with a dense black pubescence; antennæ filiform; prothorax with contiguous fossulate punctures, and with a short median raised line.

Elytra not acuminate behind; spurs straight .. .. *ursus.*

Elytra acuminate behind, inner spur oblique towards the tip .. *hirsuta.*

B^2. Hind spurs connected at the base, and of equal length, not ampliate at apex.

C^3. Antennæ sub-serrate.

Black, with the elytra purplish red, and a very broad, infuscate sutural band; prothorax with a distinctly raised median line *rufipennis.*

Black, with the elytra red; prothorax with a median elongated impression .. .. *brunneipes.*

C^2. Antennæ not sub-serrate.

Black, with the elytra pale testaceous, almost pale straw-colour.

Prothorax roughly punctate .. .. *flavipennis.*

Prothorax closely and finely punctulate .. .. *namaqua.*

C[1]. Antennæ serrate.

Black, with the elytra brownish red, very densely greyish pubescent; prothorax nearly as broad as long, strongly attenuate laterally in front, straight from the median part to the base .. .. *optata.*

B[1]. Hind spurs contiguous at the base, inner one longer than the outer.

Black, with the elytra and legs very pale flavescent; inner spur considerably longer than the outer .. .. *okiepana.*

Dark green, turning sometimes to dark blue, clothed with a black pubescence, both spurs long, contiguous and obliquely truncate at apex .. .. *metallescens.*

Black, with the elytra purplish red, clothed with a blackish and greyish pubescence; prothorax closely punctate .. .. *boschimana.*

Black, with the elytra purplish or pale red and clothed with a black and greyish pubescence; prothorax finely and closely aciculate, impressed in the centre .. .. *pallidipennis.*

Black, with the elytra pale red, clothed with a very dense greyish pubescence; prothorax finely and closely aciculate, not impressed in the centre .. .. *rubripennis.*

A[1]. Elytra depressed on the dorsal part.

B. Hind spurs quite free, of equal length, ampliate before the apex, and sharp there.

Black, with the elytra æenescent; clothed all over with a dense, erect pubescence .. .. *planidorsis.*

Iselma ursus, Thunb.,

Dissert. nov. spec. Insect., vi., 1789, p. 107; Billb., Mon. Myl., 1813, p. 73; Haag-Rut., Deutsch. Entom. Zeitschr., xxiii., 1879, p. 403.

Black, shiny, clothed with a long black pubescence, erect on the head and prothorax, more appressed on the elytra; antennæ long, filiform, joints sub-cylindrical but slightly compressed; head covered with contiguous aciculate punctures; prothorax ampliate ovate, gradually attenuated into a neck, very convex, covered with sub-scrobiculate, contiguous punctures, and having in the centre of the disk a median, sub-carinate line; scutellum closely punctulate; elytra elongated, weakly sinuate laterally, slightly ampliate behind and covered with deep foveolate punctures, somewhat unequal and separated by a narrow wall; under side very closely aciculate; legs very pubescent; hind spurs somewhat whitish, of nearly equal length, free and sharp at tip.

Length 10–13 mm.; width 3½–5 mm.

Hab. Cape Colony (Namaqualand).

ISELMA HIRSUTA, Thunb.,

Dissert. nov. spec. Insect., vi., 1789, p. 107; Haag-Rut., Deutsch. Entom. Zeitschr., 1879, p. 404.

Closely allied to what I take to be *I. ursus*, Thunb., but easily distinguished from the latter by the elytra being attenuate behind towards the apex. It is completely black and also densely hairy, the hairs on the head and prothorax being erect and very long, but the punctures although equally deep are less rugose, owing to the narrow wall separating them being less raised, the median raised line is wanting, there is a not very distinct elongated impression on each side of the central discoidal part, and the punctures of the elytra are finer but equally closely set. In my examples of *I. ursus* the hind spurs are somewhat short and straight; whereas in this species they are sub-contiguous at the base, divaricating, and oblique towards the apex which is sharp.

Length 9–11 mm.; width 3–3½ mm.

Hab. Cape Colony (Worcester).

ISELMA RUFIPENNIS, Haag-Rut.,

Deutsch. Entom. Zeitschr., 1879, p. 406.

cribraria, Péring., Trans. S. Afric. Phil. Soc., iv., 1888, p. 142.

Black, clothed with a long, dense black pubescence longer and erect on the head and prothorax, elytra purplish red with a somewhat fuscous broad sutural band; antennæ long, sub-serrate inwardly; head covered all over with round, deep, somewhat irregular punctures separated by a narrow, slightly raised interval; prothorax elongate ovate, greatly attenuated in front, covered with deep foveolate punctures, impressed on each side of the hind part of the disk, and having in the centre a plainly carinulate longitudinal line reaching neither apex nor base; elytra subcylindrical, not ampliated behind, closely coriaceous shagreened, briefly pubescent except at the base and along the sutural part where the hairs are erect; under side closely aciculate; hind spurs soldered at the base, cleft from about the median part of the length, the two points of equal length.

Males captured in September flying round a bush (*Rhus*) not in flower.

Length 11–14 mm.; width 4–4½ mm.

Hab. Cape Colony (Cape Division).

ISELMA BRUNNEIPES, Haag-Rut.,

Plate XXII., figs. 11, 11*a*.

Deutsch. Entom. Zeitschr., 1879, p. 405.

Allied to the preceding species; the shape is the same; the colour is black with the elytra red or slightly purplish red all over; the antennæ

are also sub-serrate; the head and prothorax are covered with long, black, erect hairs, and the head is closely and irregularly punctured; the prothorax however is slightly less ampliate ovate, the punctuation differs in being more regular and less rugose, the lateral discoidal impressions are indistinct, and so is the longitudinal raised line, which, when sufficiently distinct, is reduced to a mere streak; the elytra are slightly less coriaceous shagreened; the hind spurs are soldered at the base, cleft from about the median part, the inner point is slightly longer than the outer and stouter.

Length 11½–13¾ mm.; width 4–4½ mm.

Hab. Cape Colony (Namaqualand).

Iselma flavipennis, Haag-Rut.,
Deutsch. Entom. Zeitschr., 1879, p. 404

Black, with the elytra light flavescent testaceous, almost straw-colour; clothed with black hairs longer and more erect on the head and prothorax, and also very abundant on the elytra; intermediate antennal joints not sub-serrate, but slightly angular inwardly at apex; head closely and roughly punctate on the frontal part, and more finely and regularly so on the vertex; prothorax elongate ovate, slightly less attenuated in front than the preceding species, scrobiculate, very convex and having in the centre a not always very distinct impression; elytra moderately ampliate laterally in the posterior part, very closely punctate, but not distinctly coriaceous or shagreened; under side closely punctulate; hind spurs scooped at apex, the inner angle thicker and slightly longer than the outer.

Length 10–12½ mm.; width 4½–5½ mm.

Hab. Cape Colony (Namaqualand, Specktakel).

My examples were compared with Haag-Rutenberg's type.

Iselma namaqua, n. sp.

This species might at first sight be mistaken for *I. flavipennis*, of which it has the colour and shape, being likewise black with the elytra very pale testaceous, and clothed with black hairs; the difference however is in the sculpture of the prothorax which instead of being scrobiculate is covered with round, moderately deep punctures without highly raised walls, the median impression is distinct, and there is in front and behind this impression a slightly raised longitudinal line; elytra very closely punctate and somewhat coriaceous laterally; hind spurs soldered, cleft at the tip, the two spines sharp and of equal width and length.

Length 14–16½ mm.; width 5–6 mm.

Hab. Cape Colony (Namaqualand).

Iselma optata, n. sp.

Black, with the elytra brick-red, clothed with a greyish flavescent pubescence on the elytra and on the under side, and long greyish and black hairs on the head and prothorax; antennal joints strongly serrate inwardly; head and prothorax deeply scrobiculate punctate, the pubescence on both being longer and denser than in the other species; prothorax as broad as long, ampliate rounded laterally at about the median part, triangularly attenuate thence to the apex, and bearing in the centre a longitudinal raised line; elytra sub-cylindrical, slightly broader at the base than at the apex, deeply and closely punctate and not distinctly coriaceous; under side aciculate; spurs seemingly free near the base, diverging towards the apex, both of same length and thickness, and equally sharp at tip.

Length 12 mm.; width $4\frac{1}{2}$ mm.

Hab. Cape Colony (Grahamstown).

Iselma okiepana, n. sp.

Black, with the legs and even the tarsi flavescent and the elytra pale flavous, covered with a greyish flavescent pubescence, black, however, and longer and erect on the head and prothorax; antennæ filiform; head covered with deep, contiguous, equal punctures; prothorax ovate not strongly attenuate in the anterior part, and covered with deep, closely set slightly irregularly disposed punctures separated by a narrow wall; in addition to the black erect hairs there is also a fine flavescent sub-appressed pubescence which is also noticeable on the head, and in the centre of the convex disc is a longitudinal raised line obliterated at both ends; elytra closely punctate, each puncture bearing a flavescent hair on the dorsal part adjoining the suture, and a black one laterally and behind; under side closely aciculate, briefly pubescent; hind spurs very long, either fused for the greatest part of the length, or free, the inner one obliquely truncate, much longer than the outer, and both sharp at tip.

Distinguished from *I. flavipennis* and *I. namaqua* by the more filiform antennæ, the colour of the legs, the prothorax less attenuated in front, and the shape of the hind spurs.

Length 7 mm.; width 3 mm.

Hab. Cape Colony (Namaqualand).

Iselma metallescens, n. sp.

Metallic dark blue, almost black on the head and prothorax and turning blue or dark greenish on the elytra; antennæ and palps black; the whole body is clothed with a very long, erect and sub-erect black pubescence, that on the tibiæ is fulvescent; antennæ long, filiform; head

and prothorax sub-scrobiculate punctate, the punctures deep, the latter is ampliate ovate, only moderately attenuate in front, slightly bi-impressed on the disk, and having sometimes there a third, median impression; elytra sub-parallel, closely shagreened punctate; under side aciculate; hind spurs fairly long, of equal length and obliquely acuminated from about the median part to the tip.

This species is easily distinguished from the other species of the genus, except *I. planidorsis*, by its metallic colour; and from the last-named species, which is also metallic, by the non-depressed elytra.

Length 7–9½ mm.; width 2¼–3 mm.

Hab. Cape Colony (Clanwilliam, Worcester).

Iselma boschimana, n. sp.

Black, with the elytra purplish red; upper and under sides clothed with black pubescence not mixed with greyish or flavescent hairs; antennæ not sub-serrate; head and prothorax clothed with long, erect black hairs, and both covered with round, not rugose punctures not contiguous but nearly so; the prothorax is ampliate ovate but very distinctly attenuated in the anterior part, there is an impression on each side of the convex part of the disk, and occasionally a somewhat faint central one; elytra elongated, sub-cylindrical, coriaceous shagreened; hind spurs joined from the base to about the median part, both acute, inner one longer than the outer.

Length 7–9 mm.; width 2½–3 mm.

Hab. Cape Colony (Clanwilliam).

Iselma rubripennis, Cast.,
Hist. Nat. d. Ins., ii., 1840, p. 276.

rubripennis, Haag-Rut., Deuts. Entom. Zeitschr., 1879, p. 406.

Shape and size of *I. boschimana*; black, the elytra red with a slight tinge of brown; the pubescence, especially on the elytra, is plainly flavescent; the erect black setulose hairs on the head and prothorax are mixed with greyish flavescent ones; the prothorax is quite globose and covered with small round punctures almost contiguous but separated from each other by a thin wall; the elytra are elongated, sub-cylindrical, deeply and closely punctate, not coriaceous; inner spur of hind tibiæ much longer than the outer, and sharp.

This species is closely allied to *I. boschimana*, and also to *I. pallidipennis*, it differs from the former in the punctures of the prothorax, being narrower and more shallow; in *I. pallidipennis* the punctuation is finely aciculate.

The late Clem. Muller compared my examples of this species with Haag-Rutenberg's type, and I have ascertained in Paris that Castelnau's species is identical with Haag-Rutenberg's species.

Length 6–8 mm.; width 2–3¼ mm.

Hab. Cape Colony (neighbourhood of Cape Town).

ISELMA PALLIDIPENNIS, Haag-Rut.,
Deuts. Entom. Zeitschr., 1879, p. 406.

erythoptera, id. ibid., p. 407.

It is very difficult to discriminate between this species and the preceding one, the difference consisting merely in the finer and more aciculate punctuation of the prothorax; the elytra are pale brick-red with a greyish pubescence with which are black hairs intermixed, or redder brown with the pubescence more flavescent (*erythroptera*); the sculpture is that of *I. rubripennis;* the inner spur of the hind tibiæ, which is longer than the outer, is however more dilated, but this character varies.

Length 7–11 mm.; width 3–5 mm.

Hab. Cape Colony (Namaqualand).

ISELMA PLANIDORSIS, n. sp.

Black, elytra with a greyish bronze tinge; body very thickly pubescent, the pubescence is appressed but mixed with it are black setulose hairs, erect and very long on the head, prothorax, and elytra; antennæ long, joints compressed; head and prothorax closely punctate, the punctures rugose; prothorax elongated, sub-ovate, moderately attenuated in front, not very convex, the flavescent appressed pubescence forms a more distinct longitudinal line in the centre from base to apex; elytra parallel but with the dorsal part depressed, their sculpture is the same as that of the prothorax, and they have thus a punctate shagreened appearance; under side deeply aciculate punctate; the hind spurs are of equal length, ampliated in an elongate spatulate form at some distance from the base and acuminate at the tip.

Length 11–11½ mm.; width 3½ mm.

Hab. Cape Colony (Clanwilliam).

ZONITODEMA, n. gen.,
Plate XXII., figs. 10*a*, 10*b*.

Mentum longer than broad, ampliate angulate laterally in the centre ligula as broad as the apex of the mentum and with the suture distinct, parallel, deeply and sub-triangularly incised in the anterior part for about

half the length, maxillæ very long and very slender, inner lobe with an apical inner fringe of short hairs, upper lobe as long as the maxillæ, compressed, slender, fringed with hairs, ending in a long pencil of hairs, and either slightly longer, including the pencil of hairs, than the maxillary palps, or very much longer; maxillary palps very long, the ultimate joint sub-cylindrical or sub-fusiform, truncate at the tip; mandibles long, arcuate at the tip; labrum very long, elongate ovate, epistome transverse, arcuate in front, eyes large, lateral, head plainly quadrate behind the eyes; antennæ shorter than the body, moderately slender, all the joints sub-cylindrical, and of nearly equal length, even the second basal one which is not nodose; prothorax sub-quadrate or rounded laterally and attenuate in front, base distinctly marginate; scutellum moderately small, obtusely triangular; elytra sub-parallel, slightly sinuate laterally, or somewhat attenuate behind; legs and tarsi long, slender; claws cleft into two, upper tooth moderately arcuate, strongly pectinate inwardly, lower claw filiform; inner spur of hind tibiæ short but robust.

The genus is characterised by the extremely long upper lobe of the maxillæ, which is always longer than the maxillary palps, is briefly hairy, penicillate at apex and greatly resembles in some species that of *Nemognatha* and *Gnathium*.

The type of this genus is *Zonitodema viridipennis*, Fabr. and Casteln. But I am not sure of the absolute identity of this species, and were it to prove erroneous *Z. fahræi* (*collaris*, Fåhr.) would be the type.

Key to the Species.

A². Body black, with the prothorax reddish or red; elytra green or blue.

B². Abdominal segments partly red (♂) or totally red (♀).

Inner lobe of maxillæ, including the apical pencil of hairs, one-third longer than the maxillary palps; prothorax transverse, sub-trapezoidal .. .. *viridipennis.*

Inner lobe of maxillæ slightly longer than the maxillary palps; prothorax ampliate rounded laterally, slightly attenuate in front *parentalis.*

Inner lobe of maxillæ twice as long as the maxillary palps; prothorax ampliate rounded laterally, plainly attenuate in front .. *fahræi.*

B¹. Abdominal segments not red.

Inner lobe of maxillæ hardly longer than the maxillary palps; prothorax ampliate rounded in the centre, not much attenuate in front .. .. *proximus.*

A¹. Body rufous, with the elytra green.

Inner lobe of the maxillæ longer than the somewhat short palps; prothorax not attenuate in front .. .. *ruficeps.*

ZONITODEMA VIRIDIPENNIS, Fabric.,
Plate XXII., figs. 10, 10*a*, 10*b*.

Entom. Syst. Suppl., p. 103; Casteln., Hist. Nat. d. Ins., ii., p. 276.

Black, with the legs fuscous and the tarsi sub-rufescent; prothorax red, elytra metallic green; labrum and epistome sub-rufescent; abdomen with the three abdominal apical segments pale red in the male, all the segments red in the female; head triangular, strongly elongate acuminate, very briefly pubescent, but setulose on the long, ovate labrum, the surface is covered with irregular punctures somewhat scrobiculate in front and closely set, and in the centre of the frontal part is a smooth, raised line or patch, neck closely punctulate; prothorax somewhat transverse, slightly ampliate rounded laterally in the middle, as broad or very nearly so at the apex the angles of which are rounded as at the base, moderately convex on the disk, weakly and sub-remotely punctulate and glabrous; scutellum bluntly triangular; elytra elongated, slightly sinuate laterally towards the median part, non-costulate, coriaceous shagreened, and clothed with a very fine greyish pubescence; underside and legs finely aciculate, very briefly pubescent; occasionally the pectus bears an ill-defined rufescent median patch. The upper maxillary lobe is somewhat compressed, hollowed inwardly, as long as the maxillary palps, glabrous, and bears at the tip a pencil of hairs two-thirds its own length.

Length 6-11 mm.; width $2\frac{1}{4}$–$4\frac{1}{2}$ mm.

Hab. Cape Colony (Cape Town, Stellenbosch, Worcester, Paarl, Ceres, Malmesbury, King Williamstown); Transvaal (Bocksburg, Pietersburg, Pretoria, Lydenburg, Potchefstroom).

ZONITODEMA PARENTALIS, n. sp.

Very similar to the preceding species from which it differs in the shape of the prothorax which is slightly longer than broad, and attenuate, although moderately so in front, and thus resembles *Z. fahræii*, from which it can be distinguished by the upper lobe of the maxillæ which is shaped like that of *Z. viridipennis*, and which with its pencil of hairs is not as long as the head; the sculpture, colour, and vestiture are the same as in *Z. viridipennis*.

Length 6–8 mm.; width 2–$3\frac{1}{2}$ mm.

Hab. Cape Colony (Port Elizabeth); Natal (Frere); Transvaal (no exact locality).

ZONITODEMA FAHRÆI.

collaris, Fähr., Öfv. Ak. Förhd., 1870, p. 355 (name preoccupied).

Shape, size, and sculpture of *Z. viridipennis;* the colour is also the same, that is to say black with the prothorax yellowish red and the elytra

green, but turning occasionally to blue; the pubescence covering the latter is, however, less dense and shorter, but the distinctive character of this species is the very great length of the upper maxillary lobe which is nearly two-thirds the length of the whole antennæ, is very briefly hairy and bears at apex a sharp pencil of hairs equal only to one-fifth of its length. But for the pencil of hairs continuing it, this lobe would be like that of *Nemognatha* or *Gnathium*, the latter an American genus.

Length 7–9½ mm.; width 3–3½ mm.

Hab. Bechuanaland (Mafeking); Southern Rhodesia (Salisbury, Plumtree, Manica).

ZONITODEMA PROXIMA, Péring.,
Trans. S. Afric. Phil. Soc., vi., 1892, p. 126.

Black, with the prothorax pale red, and the elytra almost black but with a greenish tinge; palps and maxillæ slightly rufescent, apical joint of maxillary palps more broadly truncate at apex than the other species, upper lobe of maxillæ somewhat broad, flattened, and with the pencil of hairs included, slightly longer than the palps; head very briefly pubescent, deeply punctate, the punctures closely set, sub-rugose, a faint smooth patch in the frontal part; prothorax sub-ampliate, rounded laterally, slightly attenuate in front, sparsely punctulate with the punctures shallow, glabrous; scutellum very briefly pubescent; elytra punctate shagreened, very briefly pubescent, the pubescence greyish white; under side closely aciculate and briefly pubescent like the legs; all the abdominal segments black.

Length 6–8 mm.; width 1½–2½ mm.

Hab. Natal (Eshowe); Transvaal (Lydenburg).

ZONITODEMA RUFICEPS, Péring.,
Trans. S. Afric. Phil. Soc., iv., 1888, p. 143.

Head, prothorax, scutellum, under side, legs and palps red, antennæ black with the basal joint red, elytra metallic green; maxillary upper lobe compressed, somewhat broad, longer by itself than the maxillary palps and ending in a short pencil of hairs; head deeply and closely punctate, the punctures only slightly rugose, in the frontal part a distinct raised line; prothorax transverse, moderately rounded laterally towards the apex, but not attenuate, less sparingly punctate than in the other species of the genus; scutellum very briefly pubescent; elytra finely coriaceous shagreened, distinctly clothed with a greyish white pubescence; under side and legs very briefly pubescent.

Length 7–9 mm.; width 2–2½ mm.

Hab. Cape Colony (Namaqualand).

GEN. NEMOGNATHA, Illig.,
Plate XXII., figs. 12*a*, 12*b*.
Magaz., vi., 1807, p. 333.

Mentum sub-quadrate, slightly rounded; ligula free, also rounded laterally; mandibles long, straight, arcuate at apex; labrum as broad as long, maxillæ very weak, upper lobe filiform, very long, projecting considerably beyond the apex of the mandibles; palps somewhat long, last joint of both labial and maxillary sub-fusiform, truncate at tip; head triangular, eyes large, reniform; antennæ long, joints compressed, the second basal one knobby, one-third shorter than the joint following; prothorax short, transverse, slightly ampliate rounded laterally; scutellum longer than broad, triangular, blunt at apex; elytra parallel, not much wider than the prothorax, sinuate laterally, somewhat depressed on the discoidal part, singly rounded behind, coriaceous or shagreened; legs long, tarsi longer than the tibiæ; claws cleft from apex to base, upper hook somewhat robust, closely pectinate, lower hook very slender, simple; spurs short, slender; last abdominal segment of ♂ broadly scooped.

Key to the Species.

A². Maxillary lobe not longer than the head.

B. Elytra with a dorsal costule on each side; abdomen totally red or with the two basal segments blue .. .. *capensis*.

Elytra not distinctly costulate.

Abdomen with the three apical segments or the centre of the antepenultimate red .. .. *intermedia*.

A¹. Maxillary lobe as long as the head and thorax together.

Abdomen totally red .. .. *meraca*.

NEMOGNATHA CAPENSIS, sp. n.
Plate XXII., figs. 12, 12*a*, 12*b*.

Metallic dark blue on the upper side, turning to greenish on the pectus; all the abdominal segments red; antennæ and tarsi black; body with an extremely short pubescence; the whole head is covered with deep, slightly rugose, contiguous punctures separated by a very narrow wall; upper lobe of maxillæ projecting beyond the maxillæ to a distance equal in length to that of the head; the neck is robust and as closely punctate at the head; prothorax transverse, being slightly broader than long, slightly ampliate rounded laterally, covered with deep, sub-contiguous rugulose punctures broader than those on the head, and having in the centre a longitudinal median impression with a narrow line in it running

from the base to about the median part of the disk; scutellum and elytra punctulate shagreened, and bearing each a distinct discoidal costule running from the base to past the median part where it vanishes, and also a much less distinct, juxta-sutural one beginning at some distance from the base and slightly shorter than the discoidal; under side finely aciculate, the aciculate punctures less closely set on the pectus than on the abdomen.

Length 7–9 mm.; width 2–2½ mm.

Hab. Cape Colony (Worcester, Stellenbosch, Ceres, King Williams town).

NEMOGNATHA INTERMEDIA, n. sp.

The differences between this species and the preceding ones are very slight; the punctures on the head and prothorax are deeper and still more closely set; the prothorax is plainly more ampliated laterally in the anterior part; the elytra are alike, but the three or four apical abdominal segments are red, and the fourth is even occasionally greenish blue laterally; maxillary lobe shorter than the head.

Length 8–9½ mm.; width 2¼–3¼ mm.

Hab. Cape Colony (King Williamstown); Transvaal (Pretoria, Waterberg, Zoutpansberg).

NEMOGNATHA MERACA, n. sp.

Dark greenish blue, briefly pubescent; the whole abdomen pale red, or occasionally with the sides of the basal one greenish blue; head closely punctate, but the punctures instead of being rugulose as in the two preceding species are smooth and not quite contiguous; the maxillary lobe is greatly elongated, being quite as long as the head and prothorax taken together; in shape the prothorax is like that of *N. capensis*, that is to say slightly ampliate rounded laterally; a little in front of the median part, it has likewise a median depression from the middle to the base, and the customary transverse impression in front of the depression is moderately plain, but the punctures are round, smooth, and separated by an interval about equal to their diameter; elytra finely coriaceous sub-shagreened and without traces of any distinct costules, except in the anterior part; under side closely aciculate.

Length 7–9½ mm.; width 2–3 mm.

Hab. Mozambique (Rikatla).

ADDITIONS.

MYLABRIS AMPLECTENS, Gerst.,

Arch. f. Naturgesch., vol. 37; Decken's Reis. Gliederth., 1873, p. 207, pl. x., fig. 9.

Black, the elytra very dark chestnut brown, with the humeral part and the edge of the suture chestnut or rufous brown; whole body covered with a silky flavescent dense pubescence, appressed and somewhat shorter on the elytra; antennæ bright yellow with the four basal joints distinctly piceous black. Head irregularly but very slightly impressed, and very closely punctulate, the punctures smooth; prothorax more than usually narrowed in front, very closely but somewhat irregularly punctate, the pubescence long, the intermixed black hairs more or less erect; scutellum punctate, densely pubescent at the base; elytra elongated, finely reticulate, sub-shagreened, median dorsal costate more evident than the others; in the base is a broad arcuate dorsal lunule beginning at the suture, and broadly joined under the shoulder with a lateral marginal band; slightly above the median part is a very narrow transverse yellow band reaching from side to side, slightly wider at the outer margin than at the suture, and a post-median of the same colour, and of nearly equal width, but with the two edges slightly bi-sinuate; claws rufescent.

Easily distinguished from the other South African species with the four basal joints of antennæ black, by the two narrow posterior bands of the elytra and the connection of the basal dorsal patch with the lateral.

Length 13 mm.; width 4½ mm.

Hab. Mozambique.

This species occurs in British and German East Africa. In the type the antennæ have the three basal joints only black, and my examples from Amani are like that, whereas in my Mozambique example the four basal joints are of that colour.

DESCRIPTION OF TWO LARVÆ.

I have met with two larvæ of Meloidæ which differ so much in several characters, and one of them in mode of life, from what is hitherto known, that their description may prove of interest, although their identity cannot be ascertained.

LARVA A. ? *Mylabris.*

Body pale flavescent. Head broad, anterior frontal part with a triangular grooved area the apex of which reaches past the centre, and nearly meets there another inverted triangle obtuse at apex, and somewhat in the shape of a scutellum; clypeal part broadly transverse, and bearing several longitudinal grooves with raised intervals, the suture separating it from the frontal part is very distinct, and above that suture are two short, stiff setæ; the labrum is broad, sub-quadrate, but deeply sinuate in the centre of the apical margin, and covers the well-developed falcate mandibles; the maxillary and labial palps are thick with the apical joint very small, and as if planted in the centre of the preceding one, that of the maxillary is not very distinctly bi-articulate; the antennæ are almost like the palps, but a little longer, and seemingly four-jointed, and there are three convex ocelli set in a longitudinal line, the apical nearly touching the base of the antennæ; prothoracic ring, rigid, smooth above, meso- and metathoracic wrinkled, folded above and laterally and hardly distinguishable from the abdominal segments; all the elliptical tracheal openings very distinct; behind the tracheal opening is a slight swelling bearing a short seta; the 3–6 ventral segments and also the ultimate one have on each side a conspicuous swelling greatly resembling the pseudo-legs of caterpillars, with a longitudinal ovate elongate opening the inner margin of which is fringed with twelve acute chitinous hooks bent outwardly, and each of these false legs bear from two to four rigid setæ; the four-jointed short legs end in a moderately sharp, little incurved claw, and the posterior are slightly shorter than the others; the body is glabrous except for the few rigid setæ mentioned, but on the very finely aciculate dorsal part each segment, including the thoracic ones, has a supra-lateral, smooth, raised stigma bearing a very short hair, and a similar one, almost lateral and situated near the hind border of the segment.

Length 13 mm.; width 5 mm.

This larva was blown by a gale of wind from the ever-shifting sand dunes in the neighbourhood of Cape Town. The only wasps noticed there belong to a species of *Bembex*.

The presence of the ocelli point clearly to it being the second larval form, or Caraboid larva, of a Meloid going probably to turn into the Scarabæoid larva. Its size, however, is such that it can hardly be that of a Cantharid or Zonitid of the kinds occurring in that locality. I doubt if it can be that of a *Meloe*, because the larvæ of the different species of this genus known are not provided with the abdominal false legs. But the second instar or metamorphosis of the species of the genus *Mylabris*

is not known, and it is therefore probable that this larva belongs to the genus, as probably also does the following one.

Larva B

Body black, legs reddish brown; median dorsal part of the three rigid thoracic rings pale flavescent, prothorax with four black dots, two on each side of the median part, mesothorax with two marginal spots on each side of the median part; metathorax with four similar spots but with a longitudinal median black band of the same colour, and a sharp keel in the posterior part. Head not broader than the prothorax, greatly retracted, and with the typical triangle in the anterior part; the clypeus is narrower than in larva A and not pluri-grooved longitudinally; the labrum is similar; the antennæ are hardly distinct and show as a membranaceous cavity in which is imbedded a very short joint; the three ocelli are less in a straight line than in larva A; the three thoracic segments are corneous and rigid; the four-jointed legs are robust, more so than in larva A, and the ungulate claw is stouter and more curved; the orifices of the false legs are transverse and fringed with seriate, dark sub-compressed claws hooked outwardly and resembling cat-claws, they number from twenty-eight to thirty, and are more numerous on the upper margin, where they are continued inwardly, than on the lower. The body is glabrous, the prosternum and coxæ have a single rigid seta on each side, and the raised hair-bearing areas on the upper side of the segments are not visible.

This larva was dry and much contracted when I found it. It had emerged from the case of a ground-loving Psychid moth brought to me in a cardboard box. The presence of the ocelli show also that it is a second instar, or Caraboid larva. The shape of the orifices of the false legs and the disposition and number of the claws edging them are very different from those of larva A. It is also smaller, measuring only 9 mm. in length and 5 mm. in width.

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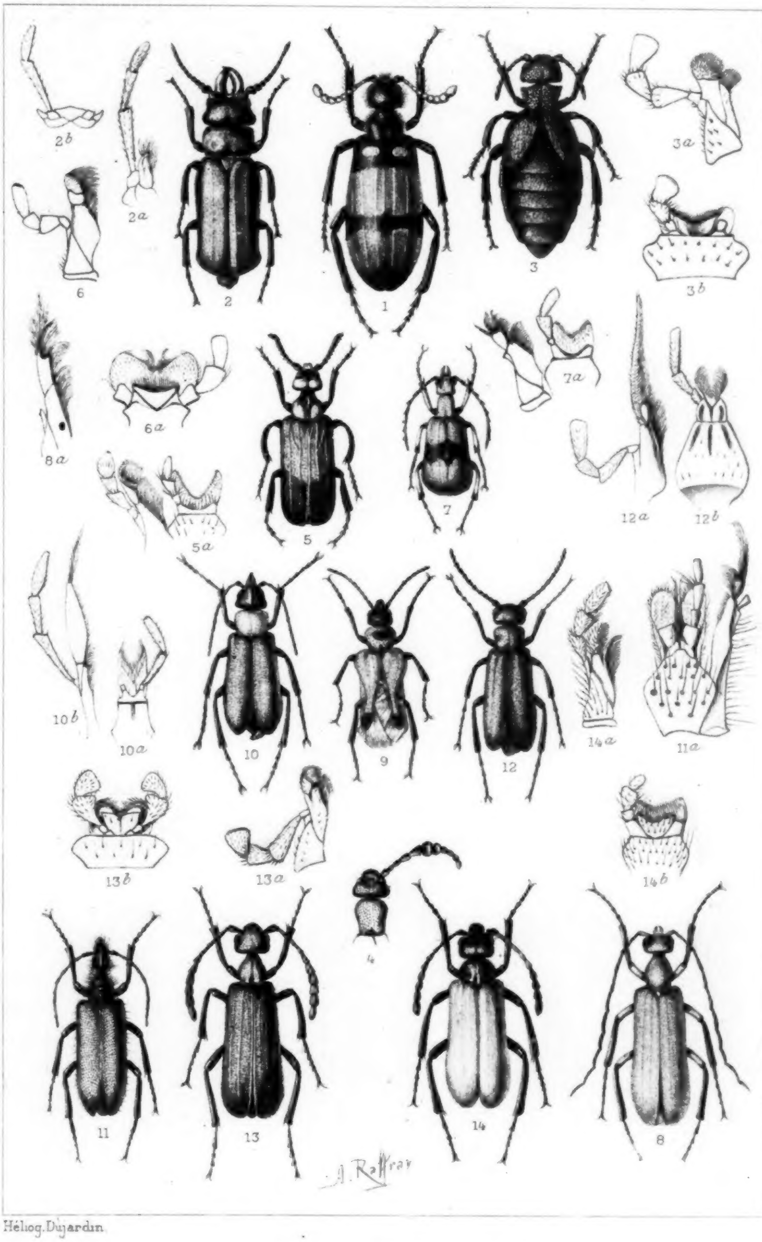
Plate XXII.

FIG.
1. Mylabris oculata.
2. Horia hottentota ♂.
3. Meloë angulatus.
4. Meloë hottentotus ♂.
5. Eletica cardinalis ♂.
6. Cantharis nitidula.
7. Zonitomorpha sellata.
8. Zonitoschema suaveola.
9. Sitaris notaticollis.
10. Zonitodema viridipennis.
11. Iselma brunneipes.
12. Nemognatha capensis.
13. Cyaneolytta pectoralis.
14. Cantharis pallidipennis.



Héliog. Dujardin.

S. AFRICAN CANTHARIDAE

*

PLATE XXIII.

FIG.	
1.	1*a*, 1*b*. 1*c*, Mylabris oculata.
2.	Mylabris, var. kakamas.
3.	,, var. vulgaris.
4.	,, var. transitoria.
5.	,, var. vicaria.
6.	,, var. tricolor.
7.	,, var. amatonga.
8.	,, var. hottentota.
9.	,, var. myops.
10.	,, buqueti.
11.	,, verecunda.
12.	,, hybrida.
13, 14, 15.	Mylabris scalaris.
16.	Mylabris tettensis.
17–18.	,, plagiata.
19.	,, hæmacta.
20.	,, var. namaqua.
21.	,, lavateræ.
22.	,, testudo.
23–24.	,, tristigma, var. permutans.
25.	,, flavicornis.
26, 27.	,, var. stali.
28, 29.	,, plagiata.

FIG.	
30, 31.	Mylabris tripunctata.
32.	Mylabris connexa.
33.	,, alterna.
34, 35, 36.	Mylabris, var. irritans.
37.	Mylabris vibex.
38.	,, dicincta.
39.	,, tripartita.
40, 41.	,, var. makalanga.
42, 43, 44.	Mylabris matoppoena.
45, 46.	Mylabris hilaris.
47.	Mylabris pertinax.
48.	,, villosa.
49.	,, bicincta.
50.	,, tincta.
51, 61.	,, matabele.
52.	,, derosa.
53.	,, pruinosa.
54, 55.	,, burmeisteri.
56.	,, gamicola.
57.	,, sedecimguttata.
58, 59.	,, picteti.
60.	,, trifolia.

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Plate XXIV.

FIG.
62. Mylabris cœca.
63. ,, zigzaga.
64. ,, dentata.
65. ,, basibicincta.
66. ,, svakopina.
67. Ceroctis (antenna).
68. ,, capensis.
69. ,, korana.
70, 71. ,, koranella.
72. ,, karroensis.
73. ,, gariepina.
74. ,, peringueyi.
75. ,, marshalli.
76. ,, blanda.
77, 78. ,, gyllenhali.
79. ,, serricornis.
80. ,, spuria.
81, 82, 83. Ceroctis aliena.
84. Ceroctis bohemani.
85. ,, groendali.
86. ,, extrema.
87. ,, quadrifasciata.
88. ,, ruficrus.
89. ,, exclamationis.
90. ,, phalerata.
91. Decatoma (antenna).
92. ,, catenata.
93. ,, caffra.
94. ,, hottentota.
95. ,, lunata.
96. ,, var. omega.
97. ,, var. umtalina.
98. ,, var. disputabilis.
99. ,, var. salisburiana.

FIG.
100. Decatoma, var. digressa.
101. ,, var. rhodesiana.
102. ,, lydenburgiana.
103. ,, var. johannis.
104. ,, sobrina.
105. ,, transvaalica.
106. ,, undata.
107. ,, stellenboschiana.
108. ,, contorta.
109, 110. ,, africana.
111. ,, insolita.
112. ,, quadriguttata.
113. ,, var. minuta.
114. ,, namaqua.
115. ,, adamantina.
116, 117. ,, histrio.
118. Coryna (antenna).
119. ,, pilosa.
120. ,, apicepustulata.
121. ,, apicalis.
122. ,, var. matabelena.
123. ,, lugens.
124. ,, elegans.
125. Actenodia (antenna).
126. ,, decemguttata.
127. ,, curtula.
128. ,, wahlbergi.
129. ,, suffusa.
130. ,, jucunda.
131. ,, boschimana.
132. Paractenodia parva.
133. Mimesthes (antenna).
134, 135, 136. Mimesthes maculicollis.

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S. AFRICAN CANTHARIDAE

PRELIMINARY NOTE ON THE DIURNAL VARIATION OF LEVEL AT KIMBERLEY.

By J. R. Sutton, M.A., Sc.D. (Cantab.), F.R.S.S.Afr., F.R.Met.S.

(Read July 15, 1908.)

This paper gives the preliminary results of observations made during the course of three years upon the diurnal variation of the level of a concrete pier supporting a seismograph. The pier itself is a solid block of concrete 1·3 m. square, standing 0·58 m. high above ground and extending 1·35 m. below ground, so that the total height of the pier is 1·93 m. Round this pier, at a distance of 15 cm. or so, is built a brick wall, which serves the double purpose of supporting the floor of the seismograph-room and keeping the earth away from the sides of the pier. Therefore the indications of the seismograph may be taken as applying to the stratum 1·35 m. below the surface of the ground. The seismograph is of the horizontal pendulum form, the boom carrying a weight of nearly 6 kilograms. There is an adjusting screw for sensibility, and a graduated micrometer screw for the purpose of measuring the tilt. The indications of the pendulum are received upon a sheet of smoked paper travelling at the rate of 15 cm. an hour. The pendulum part of the apparatus (which was made to my design, with some modification, by the Cambridge Instrument Company) has served the purpose I had in view very well. There is room for a good deal of improvement, however, in the clockwork and drum. The apparatus is housed in a wooden hut of weather-boards, the walls being double and lined with cinders. There is not a window to the hut, a space being left under the eaves for ventilation.

The pendulum is adjusted in the meridian to a mean period of 18 seconds, which, however, varies somewhat during the course of the year. A tilt of 1 second of arc corresponds to an average deviation of the extremity of the boom of almost exactly 2 mm.

In Table 1, at the end, will be found the results in monthly averages.

This table gives the mean monthly deviations from the mean position of the pendulum for each hour of the day. It appears from this that the movements in the ground which set up corresponding movements on the seismograph at Kimberley are very great. Assuming that the mean position of the pendulum indicates the undisturbed level of the ground, then the maximum westerly elongation of the pendulum occurs at 5½ h., a.m.; the maximum easterly about 4¼ h., p.m.; the median positions a little before 11 h., a.m., and 9½ h., p.m. Geometrically these movements may be represented on the hypothesis that the hemisphere facing the sun bulges out, the bulge forming a sort of meniscus to the geo-sphere. The enormous rises and falls of the surface of the land that such a supposition would postulate are, however, mechanically difficult. Moreover, it is impossible that they should be due to the alternate expansion and contraction of the earth's crust, by day and night, in the heat of the sun's rays and the nocturnal cooling. For the direct heat of the sun during the course of the day does not penetrate below a depth of 3 feet, and even then it penetrates so slowly downwards that the maximum earth temperature at a depth of 1 foot is not felt until some two hours after sunset, while it takes more than as long again before the wave of temperature reaches the 2-foot depth. Thus it is out of the question that the direct heat of the sun can affect the levels at the depth of the base of the pier on which the pendulum is fixed.

Professor Milne, who has made and discussed many elaborate experiments and observations for the purpose of ascertaining the cause of the diurnal variation of level as it has been observed in Japan and other countries, has found that it may be met with in cases 12 feet below the ground-level; but that in a space sheltered by trees from the sun's rays it is scarcely appreciable. He found further that when the character of the country to the east of a pendulum differed from that to the west—say when there were many trees or buildings on one side, but bare ground on the other—the diurnal variation of level was large. The general conclusions to which the observations at his disposal point is that the movements which take place during the day are due to the removal of a load from the side of the station most exposed to the effects of radiation. This load may be represented by aqueous vapour carried upwards and dissipated. And a very important observation in this connection is that, at many stations, on wet or cloudy days diurnal waves are absent.* It is known that in a damp country the diurnal variation of temperature may easily set up an alternate loading and unloading of the upper strata of the earth's crust. During the night, when radiation has cooled the surface, dew will be deposited from the air; and, besides, the flow of moisture in

* J. Milne, "Movements of the Earth's Crust," *Geographical Journal*, March, 1896.

consequence of the surface tension of water, will be from the warmer lower levels to the colder upper levels.* In the heat of the day, on the other hand, the same surface tension will tend to direct the flow of moisture downwards, that is to say, so much moisture as is not evaporated. It will readily be allowed therefore that the movements of moisture in a damp earth are probably in some measure competent to set up some such diurnal oscillation of the pendulum as is actually observed. At the same time it is not so obvious that the same explanation will apply to Kimberley. The soil of Kimberley is not often very wet: mostly it is very dry, and it is a curious fact that when it is dryest, namely, at the end of the winter, the range of the pendulum's excursion from west to east is twice as great as it is in summer.

Not so much connection as might have been expected can be traced between the variations of weather and the movements of the pendulum at Kimberley. Cloud and variations of barometric pressure are perhaps the most potent disturbers in a small way of the regular diurnal march of the pendulum. Whether the cloud disturbance arises because under a cloudy sky there is usually more moisture in the air, and so less evaporation from the soil, or whether it arises because the clouds mitigate the direct heat of the sun is a question. As to the barometric pressure, one would expect the elastic crust of the earth to fall under a high pressure and to rise under a low pressure. Hence we should expect the crust to sink under the increased load of air at the time of the morning maximum of pressure at, say, 10 a.m., and to rise under the lightened load at the time of the afternoon minimum of pressure, say, at 4 p.m. That is, we should expect the pendulum to swing away from the place at which the local time is 4 p.m., and to swing towards the place where it is 10 a.m. There are no very obvious indications that such is the case. Nor does the pendulum respond always in a very marked fashion to the passage of a barometric depression. This is probably due to the fact that the usual type of South African storm passes across the country in a direction S.W.–N.E., and as often as not exaggerates rather than obstructs the normal diurnal sequence of meteorological phenomena. Did our storms travel from W. to E., as certain amateur meteorologists assert, or from E. to W. as others believe, the effect upon the pendulum would of course be much more marked.

* Dr. W. J. Humphreys in pointing this out ("Note on the Movement of Water in Soils," *Bulletin of the Mount Weather Observatory*, vol. i., part 2) remarks that the temperature effect upon evaporation, condensation, and surface tension tends to conserve whatever moisture is in the earth. Surely Nature is not quite so beneficent! Would it not be more correct to argue that the temperature effect promotes loss? For surface tension brings the underground water to the surface at night just where it may be the more readily evaporated by day.

TABLE 1.

Hourly Variation in Millimetres of the Horizontal

	Midn't.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.
1903												
May	1·0 W	1·0 W	1·3 W	1·5 W	1·8 W	1·9 W	2·1 W	2·5 W	2·5 W	2·4 W	1·6 W	0·3 W
June	1·2	1·3	1·6	1·9	2·1	2·3	2·6	2·6	2·5	2·3	1·6 W	0·3 W
July	1·5	1·8	2·1	2·3	2·5	2·5	2·6	2·7	2·7	2·5	1·7 W	0·4 W
Aug.	1·9	2·2	2·4	2·5	2·7	2·8	2·8	2·6	2·2	2·0	1·3 W	0·0
Sept.	1·9	2·2	2·4	2·5	2·6	2·7	2·7	2·4	2·1	1·6	0·7 W	0·7 E
Oct.	1·9	2·0	2·1	2·1	2·2	2·2	2·1	1·9	1·5	1·1	0·3 W	0·7 E
Nov.	2·5	2·6	2·6	2·6	2·5	2·4	2·1	1·8	1·4	0·7	0·1 E	1·2 E
Dec.	1·0	1·3	1·4	1·3	1·4	1·5	1·3	1·2	0·9	0·5	0·3 E	0·9 E
1904												
Jan.	0·8	0·9	1·1	1·2	1·2	1·4	1·5	1·3	1·1	0·8	0·2 W	0·4 E
Feb.	0·0	0·2	0·4	0·5	0·7	0·9	1·1	1·2	1·1	0·7	0·1 W	0·5 E
Mar.	0·9	1·0	1·2	1·3	1·5	1·7	1·8	1·9	1·8	1·5	0·8 W	0·2 E
April	0·8	1·0	1·3	1·4	1·7	2·1	2·1	2·2	2·0	1·7	1·0 W	0·2 E
May	0·8	1·1	1·4	1·7	1·7	1·8	2·0	2·1	2·1	2·0	1·3 W	0·2 W
June	0·7	1·1	1·4	1·6	1·8	2·0	2·2	2·4	2·2	1·9	1·5 W	0·5 W
July	1·0	1·3	1·6	2·0	2·2	2·3	2·4	2·7	2·6	2·3	1·7 W	0·6 W
Aug.	1·5	1·8	2·1	2·3	2·5	2·6	2·6	2·5	2·4	2·1	1·2 W	0·2 E
Sept.	1·4	1·7	2·1	2·4	2·5	2·5	2·5	2·4	2·1	1·9	0·8 W	0·3 E
Oct.	1·5	1·9	2·2	2·4	2·5	2·5	2·3	2·0	1·5	1·0	0·4 W	0·6 E
Nov.	2·0	2·3	2·5	2·7	2·8	2·7	2·3	1·9	1·5	0·7	0·1 E	1·1 E
Dec.	1·5	1·9	2·1	2·3	2·3	2·1	1·9	1·7	1·6	1·0	0·3 W	0·5 E
1905												
Jan.	0·9	1·3	1·6	1·6	1·6	1·5	1·4	1·5	1·5	1·2	0·5 W	0·3 E
Feb.	1·6	1·8	2·1	2·1	2·0	2·0	2·0	1·8	1·6	1·0	0·3 W	0·3 E
Mar.	1·4	1·6	1·9	1·9	2·2	2·3	2·4	2·3	1·8	1·7	0·8 W	0·1 E
April	1·2	1·5	1·8	2·1	2·3	2·5	2·8	2·6	2·0	1·7	1·0 W	0·0
May	1·4	1·6	1·8	1·9	2·1	2·3	2·5	2·5	2·3	1·9	1·1 W	0·1 W
June	1·3	1·7	1·9	2·3	2·6	2·8	2·8	2·9	2·8	2·5	1·9 W	0·5 W
July	1·7	2·1	2·3	2·4	2·5	2·8	3·1	3·2	3·1	2·8	1·9 W	0·2 W
Aug.	2·0	2·3	2·6	2·8	3·0	3·1	3·3	3·4	3·1	2·3	1·5 W	0·0
Nov.	1·4	1·7	1·9	2·1	2·1	2·1	1·7	1·6	1·2	0·5	0·2 E	0·7 E
Dec.	1·3	1·5	1·7	1·7	1·7	1·7	1·7	1·6	1·4	1·0	0·4 W	0·1 E
1906												
Jan.	1·3	1·3	1·4	1·4	1·5	1·4	1·5	1·5	1·2	1·0	0·6 W	0·1 W
Feb.	1·0	1·2	1·6	1·8	2·0	2·1	2·2	2·2	1·9	1·3	0·6 W	0·1 E
Mean	1·3 W	1·6 W	1·8 W	2·0 W	2·1 W	2·2 W	2·2 W	2·1 W	1·9 W	1·5 W	0·8 W	0·2 E

TABLE 1.

PENDULUM FROM ITS MEAN POSITION IN MONTHLY MEANS.

Noon.	XIII.	XIV.	XV.	XVI.	XVII.	XVIII.	XIX.	XX.	XXI.	XXII.	XXIII.	Range.
0·9 E	1·7 E	2·4 E	3·1 E	3·6 E	3·7 E	2·7 E	2·1 E	1·0 E	0·4 E	0·0	0·5 W	6·2 mm.
1·1	2·3	3·1	3·6	4·1	4·1	3·0	2·0	0·7 E	0·2 W	0·8 W	1·1	6·7
0·9	2·2	3·3	4·1	4·7	4·9	4·0	2·3	1·1 E	0·3 E	0·5 W	1·1	7·6
1·5	2·6	3·5	4·1	4·4	4·4	3·3	2·2	1·3 E	0·7 E	0·0	0·7	7·2
1·8	2·7	3·3	3·8	4·2	4·2	3·3	1·9	0·8 E	0·1 W	0·7 W	1·3	6·9
1·5	2·1	2·5	3·0	3·4	3·3	2·4	1·1	0·0	0·7 W	1·4 W	1·9	5·6
1·9	2·4	2·8	3·2	3·5	3·5	2·8	1·4	0·4 E	0·4 W	1·0 W	1·6	6·1
1·5	1·9	2·2	2·3	2·1	2·0	1·4	1·0	0·1 W	0·9 W	1·5 W	2·1	3·8
0·8	1·2	1·6	1·9	2·1	1·9	1·6	1·0	0·4 E	0·1 W	0·6 W	1·0	3·6
1·1	1·5	1·8	1·9	1·9	1·6	1·2	0·5	0·2 E	0·9 W	1·4 W	1·7	3·1
1·0	1·5	2·0	2·2	2·3	2·3	2·0	1·5	0·7 E	0·2 E	0·1 W	0·4	4·1
1·0	1·7	2·2	2·7	3·0	2·9	2·4	1·7	0·8 E	0·1 E	0·6 W	0·9	5·2
0·8	1·5	2·3	2·8	3·1	3·3	2·8	1·9	1·1 E	0·2 E	0·3 W	0·8	5·4
0·3	1·4	2·3	2·9	3·2	3·5	2·9	1·9	1·1 E	0·3 E	0·2 W	0·7	5·9
0·6	1·9	2·6	3·4	4·1	4·4	3·6	2·4	1·4 E	0·5 E	0·2 W	0·9	7·1
1·2	2·2	2·9	3·5	3·9	4·4	3·8	2·3	1·2 E	0·3 E	0·6 W	1·2	7·0
1·6	2·3	2·9	3·1	3·4	3·6	3·1	2·1	1·1 E	0·1 E	0·6 W	1·3	6·1
1·4	2·1	2·6	2·7	3·0	3·1	2·8	1·8	1·0 E	0·3 E	0·3 W	0·8	5·6
1·9	2·4	2·7	3·0	3·2	3·2	3·0	2·2	1·2 E	0·2 E	0·5 W	1·0	6·0
1·4	2·0	2·4	2·8	3·0	3·3	2·9	2·2	0·9 E	0·1 W	0·8 W	1·4	5·6
1·0	1·6	1·9	2·3	2·5	2·5	2·1	1·4	0·6 E	0·0	0·3 W	0·7	4·1
1·0	1·5	2·0	2·4	2·8	2·9	2·6	2·0	1·2 E	0·4 E	0·2 W	0·6	5·0
1·2	1·9	2·4	2·7	2·8	2·8	2·5	1·9	1·0 E	0·5 E	0·2 E	0·3	5·2
1·1	2·0	2·8	3·1	3·2	3·1	2·7	2·0	1·2 E	0·7 E	0·1 E	0·3	6·0
1·3	2·1	2·9	3·3	3·5	3·4	2·9	1·9	1·0 E	0·1 E	0·3 W	0·9	6·0
1·1	2·4	3·2	3·7	3·9	4·0	3·5	2·6	1·7 E	0·8 E	0·2 E	0·5	6·9
1·4	2·9	3·7	4·5	5·0	4·8	3·8	2·5	1·4 E	0·3 E	0·8 W	1·7	8·2
1·5	2·9	3·7	4·3	4·8	4·5	3·8	2·8	1·6 E	0·6 E	0·4 W	1·0	8·2
1·2	1·6	2·1	2·4	2·5	2·3	2·0	1·5	0·8 E	0·4 E	0·2 W	0·7	4·6
0·6	1·1	1·5	1·9	2·3	2·4	2·2	1·5	1·0 E	0·5 E	0·1 E	0·4	4·1
0·5	1·2	1·5	1·8	2·0	2·3	2·2	1·8	1·1 E	0·3 E	0·2 W	0·7	3·8
0·8	1·5	1·9	2·4	2·7	2·7	2·5	2·0	1·2 E	0·6 E	0·0	0·6	4·9
1·2 E	1·9 E	2·5 E	3·0 E	3·3 E	3·3 E	2·7 E	1·9 E	0·9 E	0·2 E	0·3 W	1·0 W	5·5 mm.

One very remarkable fact is that in the years under discussion there was a strong tendency for the pendulum to deviate more and more to the west of its mean position during the winter, and to the east during the summer. This may be provisionally explained—pending further investigation—as a tilting of the whole sub-continent in response to the loading of the east coast by rain in summer and the west coast in winter, supplemented, of course, by the unloading of the west coast in summer by evaporation and of the east coast in winter. Be the cause of this what it may, the effect is too great to be measured satisfactorily by any means at my command.*

It is interesting to compare the harmonic elements of temperature and barometric pressure (Table 2) with those of the variation of level. In each case the time is counted from local mean midnight. In the case of the latter element the results are expressed in terms of the deviation in millimetres to the west. The near agreement in point of time of the second harmonic terms of barometric pressure, temperature variability, and variation of level is certainly remarkable. If this is to be regarded as having a physical explanation it would seem to be that the original gradients set up by the principal agencies—whatever they may be, whether temperature or the movement of underground moisture—in the ground are modified by the semi-diurnal wave of pressure so that the final gradients are actually steeper at the places where the local time is $9\frac{1}{2}$ h. a.m. and p.m.

Perhaps a word in conclusion may not be out of place as to the advantages of such a place as Kimberley for seismological research. Griqualand West is exactly the uniform and equally exposed prairie-like plain that Professor Milne asks for. Moreover, it is almost exactly in the centre of the South African Tableland. The great majority of stations in the world are not well balanced, so to speak, in their position with reference to land and water; and as a consequence most of them are relatively too near the sea to get the diurnal oscillation of level clear of such disturbances as are set up by the tides and waves of the ocean.†

* Observations of the variation of level made at the Royal Observatory, Cape Town, at a depth of 30 feet, show a tilt to the east in winter, and to the west in summer—just the opposite to what is found at Kimberley. The line of greatest winter rain is, as it happens, somewhat to the east of Cape Town. This result would seem to confirm the suggestion that the annual oscillation of level is due to incidence of rainfall.

† For an interesting discussion of the general question see a paper by Prof. E. Lagrange, on "Périodicité Sismique," in *Bulletin de la Société belge d'Astronomie*, July, 1904. It appears from this that the diurnal variation of level at Uccle is extremely feeble. At Strassburg, four times as far from the sea, it is much greater. Mr. T. F. Claxton, in *Results of Mag. and Met. Observations* made at Mauritius in 1906, mentions the curious fact that when the Milne seismograph of the Port Alfred Observatory was removed from the electrometer hut to the magnet basement the phase was changed by approximately 12 hours and the amplitude reduced to about one-fourth.

TABLE 2.

SOME HARMONIC CONSTANTS IN THE DIURNAL CURVES OF BAROMETRIC PRESSURE, TEMPERATURE VARIATION, TEMPERATURE VARIABILITY, AND VARIATION OF LEVEL, AT KIMBERLEY.

	Barometric Pressure.	Temperature Variation.	Temperature Variability.	Variation of Level.
V_1	355°	229°	320°	24°
V_2	154	58	150	159
V_3	358	16	114	194
V_4	351	215	—	288
u_1	·0276	12·009	3·269	2·690
u_2	·0243	3·074	1·568	·607
u_3	·0017	·697	·654	·040
u_4	·0001	·764	—	·094

A DIPLOSTIGMATIC PLANT, *SEBÆA EXACOIDES* (L.) SCHINZ (*BELMONTIA CORDATA* L.).

By R. Marloth, Ph.D., M.A., F.R.S.S.Afr.

(Read September 16, 1908.)

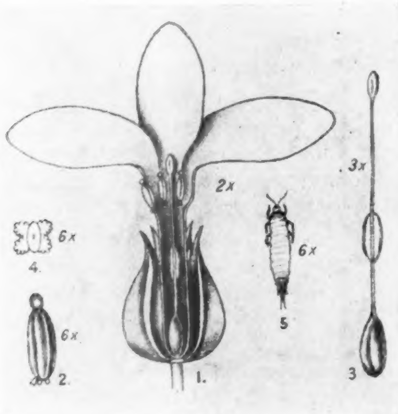
The genus *Belmontia* was separated from *Sebæa* by Ernst Meyer in 1835 on account of the included stamens. While in the genus *Sebæa* proper the stamens are inserted at the mouth of the corolla tube and are consequently exserted, they are, owing to their lower insertion, hidden in the tube of the corolla on the species included in *Belmontia*. Recently, however, both genera have been re-united by Schinz,* owing to the existence of intermediate forms; hence the pretty little plant generally known as *Belmontia cordata* would have to be called *Sebæa cordata*, if it had not been shown at the same time by Schinz that there exists an older Linnæan name for it, viz., *Gentiana exacoides*. Consequently, according to the international rules of nomenclature, this older specific name must have the preference, and the plant is *Sebæa exacoides* (L.) Schinz.

The flowers of most species of *Sebæa* possess two curious organs, viz., the Brown's bodies—a term introduced by Schinz—and the papillose ridges of the style. The Brown's bodies are little appendages of the anthers, existing either at the apex of the anther only—in which case there is only the one apical body—or also at the base of the anther, in which case there are three such bodies, one apical and two basal ones. Until recently these bodies were called glands, but Schinz has shown, that they contain sugar and that they are often removed from the flower. This he ascribes to the action of insects, which rob the flowers of these bodies, and he looks upon the Brown's bodies as a bait for the attraction of insects, complaining at the same time of the indifference of Cape botanists, who have not paid any attention to the visitors of these flowers. Professor Schinz would, however, have been less severe in his judgment, if he possessed my experience in this matter. For twenty-five years I have seen hundreds or thousands of plants of *Belmontia cordata* every year without ever observing a single insect on its flowers, and yet this is, for some special reason, a

* Schinz, H., Versuchveiner monograph. Uebersicht der Gattung *Sebæa* R. Br.; Mitt. der Geogr. Ges. in Lübeck, Heft 17, 1903.

favourite spring flower of mine, and the relationships of plants and animals are one of my favourite studies.

The other peculiarity of structure of the flowers of *Sebæa* is the swollen portion of the style, designated by various names, *e.g.*, as a hairy ring,* or a tubercular thickening,† but described more correctly by Schinz ‡ as *Papillenwulst* (papillose swelling). It is not a ring, but consists of two flat longitudinal swellings, separated by a narrow portion of the smooth style. Schinz says: "The Brown's bodies and the papillose swelling must have something to do with the pollination of the flowers by means of insects; the function of the former is comprehensible, but that of the latter not—at least, not at present." My observations on *Sebæa exacoides* do, I think, now supply this information.



SEBÆA EXACOIDES (*L.*), *Schinz.*

1. Flower, ⅔ of corolla removed. 2. Stamen. 3. Pistil.
4. Section through secondary stigma. 5. Thrips (larva.)

When, years ago, I examined the swollen part of the style for the first time under the microscope, I could not help noticing, that it possessed exactly the same structure as the receptive surface of the knob-shaped stigma, and that numerous pollen grains were adhering to the papillose surface. Gradually I came to the conclusion, that this might be a stigmatic organ, but as nothing of a similar kind was known from other plants I hesitated to express this opinion without further investigations.

* Gilg in Engl. Pflanz. Fam. IV., 2, p. 64. † Baker in Flora Trop. Afr. IV., p. 546.
‡ Schinz, *loc. cit.*, pp. 6 and 7.

Recently, however, I had, in connection with some other work, to study these plants again, and found in the course of this research that some pollen grains had germinated on this papillose surface. By staining the style with magenta, &c., one can find numerous pollen-tubes in the tissue of the style, below the swollen part as well as above it; hence their presence in the lower portion of the style would not necessarily prove, that they came from the swollen portion, as they may just as well have descended from the terminal stigma. Owing to lack of time I have not been able to actually trace the tubes from the grains down through the style into the ovary, but I have seen some enter the style at the swollen portion, hence the function of this latter organ is fairly clear. It is a secondary stigma, which means that *Sebæa exacoides*, and probably most other species of *Sebæa*, possess two stigmatic organs; they are, as I propose to call this structure, diplostigmatic.

If one examines flowers of *Sebæa* of different age, one finds that in flowers which have just opened the terminal stigma is still within the tube of the corolla, just blocking the entrance to it, whilst the secondary stigma appears still fairly smooth, with short papillæ only and without adhering pollen. At a later stage—perhaps a week later (the flowers last fairly long)—the terminal stigma protrudes from the tube about 1 to 2 mm., but it is brown and shrivelled, whilst the secondary stigma is quite fresh, having now longer papillæ and being generally covered with adhering pollen grains. The function of the secondary stigma is therefore evidently to secure self-pollination when cross-pollination should not have been effected, for when the style gradually lengthens its papillose swelling touches the base of the anthers.

During all these investigations, however, I found no clue with regard to the insects which, I felt sure, must visit these flowers. Their colour is a bright yellow, and there are even orange-coloured spots at the entrance to the corolla tube; the flowers possess a pleasant although weak clove-like scent, especially in the evening, and the anthers are provided with saccharine appendages, the Brown's bodies. In all probability, I thought, it must be some nocturnal insect, and often I watched the flowers during my rambles on moonlight evenings or in the dawn of the early morning, but in vain. This season, however, I have succeeded in finding the visitor and with him the explanation of previous failures. The insect is not a moth nor a fly, but an almost microscopically small creature belonging to the Thripsidæ (Physopoda), a family of the Orthoptera. Their length is only 1 or 1½ mm., but when they are crawling up the style and attempt to force their way through the mass of pollen which completely fills the narrow space between the style and the anthers, they force a considerable quantity of the pollen down upon the secondary stigma. At the same time they cover themselves with numerous pollen grains, as can be seen on

the mounted specimens, although these had been kept in alcohol and subsequently in glycerin before they were mounted.

When the winged forms finally make good their escape they carry the pollen to other flowers, to which they are attracted by the Brown's bodies, for they live on the juices of plants and would consequently eagerly suck the sweet contents of these bodies. Thus they would effect cross-pollination.

Recapitulation: The flowers of *Sebæa exacoides*, and probably of all species of *Sebæa*, are diplostigmatic, the swollen portion of the style being a secondary stigma.

The function of the secondary stigma appears to be in the first instance the securing of self-pollination when cross-pollination should not have been effected, but it will also increase the probability of cross-pollination.

The flowers are visited by one or more species of thrips, which obtain the saccharine contents of the Brown's bodies by piercing them with their mouth parts. On leaving the flower they carry its pollen to others, thereby effecting cross-pollination.

SOME NEW SPECIES OF *EUPHORBIA* FROM SOUTH AFRICA.

By R. Marloth, Ph.D., M.A., F.R.S.S.Afr.

Having recently visited the coast districts of Great Namaqualand, I found, that in the desert-belt, which extends about 50 to 60 km. inland, and which bears no trace of vegetation for miles, several shrubby species of Euphorbia form the most prominent features of the scanty vegetation, as it exists on the slopes of the hills of the region. On endeavouring to identify these plants I ascertained that three of them were undescribed. I take this opportunity of publishing a few other species, which I have had in cultivation for a number of years. The difficulty of identification is much increased by the incompleteness of the specimens, as they exist in European herbaria, and the defective descriptions based upon these specimens.

Two other species were found in the rocky belt near the coast, viz.: *E. brachiata* E. Mey and *E. stapelioides* Boiss. The former, a dichotomously branched, leafless shrub, generally about a foot high, is fairly common, often the only plant visible; the other one, a small succulent plant growing between rocks, is much rarer.

Euphorbia pulvinata spec. nov. (Sect. Diacanthium).

Caulis subterraneus, brevissimus, apice ampliatus, ramis brevibus simplicibus in pulvino depresso aggregatis, verticaliter 7-costatis, profunde inter costas sulcatis, pedunculis sterilibus longis spinæformibus pungentibus. Folia linearia decidua. Cyathia in apice ramorum sessilia aggregata. Involucrum 2–3 foliolis ovatis ciliatis suffultum, longe-campanulatum, lobis brevissimis retusis denticulatis, glandulis rubris erectis hemisphæricis margine repandis.

The plant spreads laterally by producing numerous branches of equal length, thus forming a slightly convex cushion-shaped mass, up to 50 cm. in diam. The length of the branches is 3–6 cm., their diam. (with ribs) 3–4 cm.; the number of ribs is mostly 7, sometimes 6 or 8, their edge is slightly crenate, their height and width 7–9 mm., the length of the spines 10–15 mm., the diam. of the cyathium, which is dark red, 4 mm.; leaves 5–10 mm.

Growing in rocky ground near Queenstown, flowering in Nov., Marloth No. 4372, also gathered by Mr. E. Galpin and Mr. E. Phillips. (See Fig. 1.)

E. gummifera Boissier (amended description).

Fruticosa, ramosa, tota minute albo-tuberculata, ramis rigidis erectis, ramulorum lateralium brevissimorum decurrentia subangulatis. Folia? Cyathia sessilia, glomerata, foliolo ovato-acuminato tomentoso suffulta; involucrum campanulatum hirsutum, lobis ovatis acutis integris, extus hirsutis, glandulis patentibus, transverse ovalibus.

A rounded shrub, similar in shape to *E. mauritanica* as growing in the karroo, but with ribbed, woody branches and a hard, whitish, finely tuberculated epidermis, which evidently forms an excellent protection against the drifting sand and grit of the desert plains and hills on which the plant thrives in spite of the sandstorms. The cyathia are crowded together on short lateral spurs of the branches, the bracts and involucres being thickly hirsute or tomentose. The shrubs are nearly egg-shaped or somewhat stouter at their base, 1–2 m. high; the final branches 6–8 mm. thick; the cyathia 3 mm. in diam.

On sandy plains and slopes of the desert Namib near Tschaukaib at an alt. of 800 m. and a distance from the coast of Angra Pequena of 60 km. Marloth No. 4636.

This is the first socially growing plant, which one meets in coming from the coast.

Boissier states (DC. prodr. vol. xv., 2. p. 97) that the plant resembles *E. cervicornis*, but this opinion is based on fragmentary herbarium specimens, as the two species are very different in habit. *E. cervicornis* is a much smaller plant with stout succulent branches and large leaves. It is eagerly eaten by goats and sheep, while *E. gummifera* is not only too woody to serve as food for the animals, but possesses a nauseous and irritating smell.

E. lignosa spec. nov. (Sect. Lyciopsis).

Frutex ramosissimus, compactus, 1–2 pedalis, ramulis crassis rigidis acutis subviridibus. Cyathia terminalia solitaria vel terna; involucrum campanulatum lobis brevissimis retusis subdenticulatis, glandulis infundibuliformibus, sub-bilabiatis, labio exteriori 3–4 palmatifido. Capsula globosa punctata pilosa, 4 mm. diam.

A much-branched very rigid shrub with sharp-pointed branches, forming a nearly hemispherical compact mass up to 1 m. in diam. Leaves, on young shoots only, linear-oblong, 10–15 mm. Flowers probably in winter, as only a few old flowers could be found in November. The species does not readily fit into any of the sections

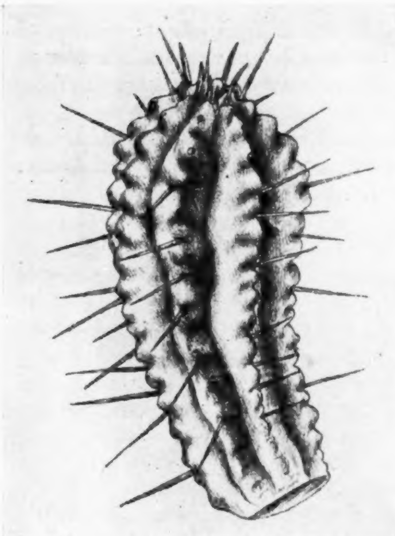


Fig. 1.—Euphorbia pulvinata.
A single branch, *nat. size.*

Fig. 3.—E. namibensis.
A young plant, reduced to ½.

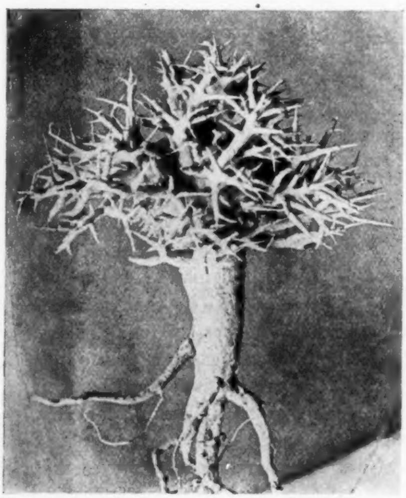


Fig. 2.—E. lignosa.
A medium-sized plant, reduced to ⅓.

Fig. 4.—crassipes.
The flowering top of a branch, nat. size,
with gland and perianth segment.

established by Boissier. It is placed here into Lyciopsis on account of its habit, but, as pointed out by Bentham in the Genera Plantarum, habit does not always coincide with the characters taken from the form of the glands.

On stony ground or rocks in the desert of Great Namaqualand, near Tschaukaib, at an alt. of 900 m. and a distance of 60 km. from the coast of Angra Pequena. Marloth No. 4637. (See Fig. 2.)

E. namibensis spec. nov. (Sect. Medusea).

Caulis crassus globosus vel breve-cylindricus; rami breves succulenti podariis elongatis conicis, foliis linearibus deciduis. Involucra sessilia campanulata basi bifoliolata, lobis brevissimis obtusis ciliatis, glandulis bilabiatis; labio superiori brevi mutico vel subemarginato, inferiori in 3–4 lacinias subulatas partito; stylis haud divisis.

The stem is whitish, club-shaped, nearly globose or somewhat elongate, up to 15 cm. in diam. and 15–20 cm. high. The cylindrical branches are 2–4 cm. long and 1 cm. in diam.; the leaves, which appear only for a short time after rain, are 10–15 mm. long; diam. of cyathium, 8–10 mm.

Growing in the stony plains of the desert "Namib," near Tschaukaib, at an altitude of 800 m. and a distance of 50 km. from the coast of Angra Pequena. Marloth No. 4635. (See Fig. 3.)

This is the plant figured in Schultze* as *E. Marlothii* Pax, and although the name is given on the authority of Prof. Pax, it is obviously an error. *Euphorbia Marlothii* belongs to another section, being very different in appearance and systematic characters. A fairly good figure of the true *E. Marlothii* is given by Berger in "Sukkulente Euphorbien," p. 117.

E. crassipes spec. nov. (Sect. Dactylanthes).

Caulis brevis globoso-cylindricus, ramis crassis numerosis brevibus cylindricis. Cyathia in apicibus ramorum stipitata, basin 3–5 foliolis spathulatis ciliatis suffulta. Involucrum campanulatum lobis ovatis lacerato-ciliatis, glandulis patentibus, concavo-bilabiatis, labio superiori brevi, emarginato, labio inferiori breviter 3–4 dentato. Pedunculi deflorati persistentes inermes. Styli inferne coaliti apice sub-bilobi.

The stem is 10–15 cm. thick and high, flattened at the apex, and bearing numerous short fleshy branches, the lower ones gradually shrivelling up and exposing the bare stem. Sometimes the stem remains quite short and buried in the ground, the branches forming a rosette 15–20 cm. in diam. Length of branches 4–6 cm., their diam. 10–15 mm.; length of persistent peduncles (floriferous branchlets) 15–20 mm., they are woody but not sharp pointed. Diam. of cyathium 4 mm., without the teeth of the glands, fig. 4.

* Schultze, L., Aus Namaland und Kalahari, Jena 1907, p. 88.

Growing in stony ground of the karroo, near Prince Albert and Beaufort West. Marloth No. 4397.

This is nearly allied to *E. anacantha* Boissier, but easily distinguished by the persistent stalks of the inflorescences.

E. esculenta Marloth (Sect. Pseudomedusea Berger).

(See figure in: Marloth, Das Kapland Jena, 1908, p. 247.)

Planta succulenta, habitu *E. Caput Medusæ*, sed cyathiis differens. Involucrum campanulatum lobis brevibus conniventibus, valde albo-fimbriatis; glandulis minimis calliformibus brunneis verticaliter adpressis.

The stem is obconical or club-shaped, buried in the ground, flat at the apex, 10–20 cm. in diam., bearing numerous thick branches arranged in a rosette of half a meter in diam., each branch being from 5–15 cm. long and 15–20 mm. thick. The flowers are aggregated at the ends of the branches, white, sweet-scented like violets.

Klipplaat in the Eastern karroo, flowering in spring. Marloth No. 4162.

This plant is very common in the karroo of Graaff Reinet, Aberdeen, and Jansenville, and forms a very nutritious food for the stock in times of drought. Formerly it was also occasionally roasted in the ashes for human use. Owing to its resemblance to *E. Caput Medusæ*, it has been often quoted under this name. The latter, however, is not edible, and possesses flowers of quite a different structure.

Dupl. paging

NOTE ON A THEOREM REGARDING A SUM OF DIFFERENTIAL-COEFFICIENTS OF PRINCIPAL MINORS OF A JACOBIAN.

By Thomas Muir, LL.D., F.R.S.

(Read March 17, 1909.)

1. The theorem in question is that which plays so important a part in Jacobi's method* of determining the last integrating factor for a set of differential equations, and which he accordingly styled his "fundamental lemma." It may be enunciated in simple manner as follows: *If* A_1, A_2, ..., A_n *be the co-factors of the elements of any row of a Jacobian whose independent variables are* $x_1, x_2, \ldots, x_n$, *then*

$$\frac{\partial A_1}{\partial x_1} + \frac{\partial A_2}{\partial x_2} + \ldots . + \frac{\partial A_n}{\partial x_n} = 0.$$

2. Of this theorem in 1854 Donkin gave a very peculiar demonstration.† Separating the symbols of operation

$$\frac{\partial}{\partial x_1}, \quad \frac{\partial}{\partial x_2}, \quad \ldots .$$

from the subjects operated on, which in the case of $n = 4$ may be written

$$\begin{vmatrix} \frac{\partial u}{\partial x_2} & \frac{\partial v}{\partial x_3} & \frac{\partial w}{\partial x_4} \end{vmatrix}, \quad -\begin{vmatrix} \frac{\partial u}{\partial x_1} & \frac{\partial v}{\partial x_3} & \frac{\partial w}{\partial x_4} \end{vmatrix}, \ldots \ldots$$

he was, of course, enabled to put the left-hand member in the form

$$\begin{vmatrix} \frac{\partial}{\partial x_1} & \frac{\partial}{\partial x_2} & \frac{\partial}{\partial x_3} & \frac{\partial}{\partial x_4} \\ \frac{\partial u}{\partial x_1} & \frac{\partial u}{\partial x_2} & \frac{\partial u}{\partial x_3} & \frac{\partial u}{\partial x_4} \\ \frac{\partial v}{\partial x_1} & \frac{\partial v}{\partial x_2} & \frac{\partial v}{\partial x_3} & \frac{\partial v}{\partial x_4} \\ \frac{\partial w}{\partial x_1} & \frac{\partial w}{\partial x_2} & \frac{\partial w}{\partial x_3} & \frac{\partial w}{\partial x_4} \end{vmatrix}.$$

* Jacobi, C. G. J., Theoria novi multiplicatoris systemati æquationum differentialium vulgarium applicandi. *Crelle's Journal*, xxvii., pp. 169–268; xxix., pp. 213–279, 333–375.

† Donkin, W. F., Demonstration of a theorem of Jacobi relative to functional determinants. *Cambridge and Dub. Math. Journ.*, ix., pp. 161–163.

He then contrived to satisfy himself that for the first element of each column he was entitled to substitute an expression which turned out to be the sum of the remaining elements of the column. The vanishing of the determinant was thus concluded to be inevitable.

3. Now it is readily seen that in effect this was equivalent to saying that the determinant could be expressed as the sum of $n-1$ determinants of the nth order, that is to say, as an aggregate of $(n-1)(n!)$ terms of the nth degree in the first differential-coefficients of $u, v, \ldots$; whereas A_1 being an aggregate of $(n-1)!$ terms of the $(n-1)$th degreee in the said differential-coefficients, $\frac{\partial A_1}{\partial x_1}$ must be an aggregate of $(n-1)!(n-1)!$ terms in each of which a *second* differential-coefficient occurs, and therefore $\Sigma\frac{\partial A_1}{\partial x_1}$ must be an aggregate of $(n-1)!\,n!$ terms of this latter kind. Such being the case, doubt is at once thrown on the so-called demonstration. A little examination of the reasoning employed fully justifies us in setting it aside as misleading and fallacious.

4. Fortunately our scepticism leads us at the same time to produce as a substitute a valid proof not hitherto made known.

Recalling the fact that the differential-coefficient of an n-line determinant can be expressed as the sum of n determinants of the same order, we see that $\Sigma\frac{\partial A_1}{\partial x_1}$ can be expressed as an array of n rows with $n-1$ determinants in each row. If then the elements of each column in this array be added, it will be found that the result is zero, in accordance with a well-known theorem of Kronecker's regarding vanishing aggregates of determinants.

Thus, when $n=4$, we have on writing u_{rs} for $\partial^2 u/\partial x_r \partial x_s$

$$\frac{\partial A_1}{\partial x_1} = \begin{vmatrix} u_{12} & u_{13} & u_{14} \\ v_2 & v_3 & v_4 \\ w_2 & w_3 & w_4 \end{vmatrix} + \begin{vmatrix} u_2 & u_3 & u_4 \\ v_{12} & v_{13} & v_{14} \\ w_2 & w_3 & w_4 \end{vmatrix} + \begin{vmatrix} u_2 & u_3 & u_4 \\ v_2 & v_3 & v_4 \\ w_{12} & w_{13} & w_{14} \end{vmatrix}.$$

$$\frac{\partial A_2}{\partial x_2} = -\begin{vmatrix} u_{21} & u_{23} & u_{24} \\ v_1 & v_3 & v_4 \\ w_1 & w_3 & w_4 \end{vmatrix} - \begin{vmatrix} u_1 & u_3 & u_4 \\ v_{21} & v_{23} & v_{24} \\ w_1 & w_3 & w_4 \end{vmatrix} - \begin{vmatrix} u_1 & u_3 & u_4 \\ v_1 & v_3 & v_4 \\ w_{21} & w_{23} & w_{24} \end{vmatrix},$$

$$\frac{\partial A_3}{\partial x_3} = \begin{vmatrix} u_{31} & u_{32} & u_{34} \\ v_1 & v_2 & v_4 \\ w_1 & w_2 & w_4 \end{vmatrix} + \begin{vmatrix} u_1 & u_2 & u_4 \\ v_{31} & v_{32} & v_{34} \\ w_1 & w_2 & w_4 \end{vmatrix} + \begin{vmatrix} u_1 & u_2 & u_4 \\ v_1 & v_2 & v_4 \\ w_{31} & w_{32} & w_{34} \end{vmatrix}.$$

$$\frac{\partial A_4}{\partial x_4} = -\begin{vmatrix} u_{41} & u_{42} & u_{43} \\ v_1 & v_2 & v_3 \\ w_1 & w_2 & w_3 \end{vmatrix} - \begin{vmatrix} u_1 & u_2 & u_3 \\ v_{41} & v_{42} & v_{43} \\ w_1 & w_2 & w_3 \end{vmatrix} - \begin{vmatrix} u_1 & u_2 & u_3 \\ v_1 & v_2 & v_3 \\ w_{41} & w_{42} & w_{43} \end{vmatrix},$$

and therefore by addition

$$\Sigma\frac{\partial A_1}{\partial x_1} = 0 + 0 + 0.$$

5. When we recall that Kronecker's theorem here used was discovered by him as a property of minors of an *axisymmetric* determinant, and that indeed it has not yet been formulated apart from this connection, the interest in the demonstration is greatly heightened. For example, to assert the vanishing of the first column of determinants in the preceding paragraph is the same as to say in reference to the axisymmetric determinant

$$\begin{vmatrix} \cdot & \cdot & v_1 & v_2 & v_3 & v_4 \\ \cdot & \cdot & w_1 & w_2 & w_3 & w_4 \\ v_1 & w_1 & \cdot & u_{12} & u_{13} & u_{14} \\ v_2 & w_2 & u_{12} & \cdot & u_{23} & u_{24} \\ v_3 & w_3 & u_{13} & u_{23} & \cdot & u_{34} \\ v_4 & w_4 & u_{14} & u_{24} & u_{34} & \cdot \end{vmatrix}$$

that

$$\begin{vmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \end{vmatrix} - \begin{vmatrix} 1 & 2 & 4 \\ 3 & 5 & 6 \end{vmatrix} + \begin{vmatrix} 1 & 2 & 5 \\ 3 & 4 & 6 \end{vmatrix} - \begin{vmatrix} 1 & 2 & 6 \\ 3 & 4 & 5 \end{vmatrix} = 0,$$

where $\begin{vmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \end{vmatrix}$ stands for the three-line minor whose elements are to be found in the 1st, 2nd, 3rd rows and in the 4th, 5th, 6th columns.

THE SPECTRUM OF THE RUBY—A NEW CHARACTERISTIC TEST.

By J. Moir, M.A., D.Sc., F.C.S.

(Read March 17, 1909.)

On placing a ruby before the slit of a spectroscope, using strong illumination, preferably sunlight, a very remarkable absorption-spectrum is obtained, which differs from all others in resembling an ordinary *emission* spectrum. The light is cut off except for a sharp narrow red band situated just beyond the B line of the solar spectrum, and this band bears the closest resemblance to the potassium or lithium line as commonly seen in the Bunsen flame when a rather wide slit is used. The limiting wave-lengths of the band are about 6,915 and 6,945 tenthmetres. Its width is therefore about half its distance from the B line in the solar spectrum. The phenomenon is most easily seen in the pale rubies; corundum with even the faintest pink shade generally shows the characteristic line; but even the darkest true rubies show it if the illumination be strong enough. No other pink or red stone—pyrope, almandine, spinel, or tourmaline, for example—shows this line, which would therefore appear to be characteristic of the colouring of the true ruby. In addition to the red line the spectrum contains wide green and orange bands which are, however, not characteristic.

AN UPPER LIMIT FOR THE VALUE OF A DETERMINANT.

BY THOMAS MUIR, LL.D., F.R.S.

(Read March 17, 1909.)

1. In 1885 I was led to establish the theorem, *If* s_r^2 *be the sum of the squares of the elements of the* r*th row of a determinant* δ, *and* S_r^2 *be the sum of the squares of the elements of the corresponding row of the adjugate determinant* Δ, *then* $\delta \leqq s_r S_r$: and by means of it succeeded in proving for Sir William Thomson (afterward Lord Kelvin) the further inequality

$$\delta \leqq s_1 s_2 s_3 \ldots$$

Taking, for example, the case where δ is of the fourth order, we obtain by using the former theorem four times

$$s_1 S_1 . s_2 S_2 . s_3 S_3 . s_4 S_4 \geqq \delta^4,$$

and therefore by Cauchy's theorem regarding the adjugate determinant

$$s_1 s_2 s_3 s_4 . S_1 S_2 S_3 S_4 \geqq \delta . \Delta.$$

From this the second theorem results at once.

Although it was agreed at the time that the latter theorem should be published in the *Educational Times*, it did not actually appear until 1901.*

2. It was in 1893 that the subject first assumed importance, M. Hadamard having in that year drawn the attention of mathematicians to it by means of two different papers.† His fundamental result, which is an extension of the theorem just mentioned so as to include determinants with complex elements, may be formally enunciated thus: *If* s_r^2 *be the sum*

* See *Educ. Times*, liv., p. 83, or *Math. from Educ. Times* (2), i., pp. 52, 53. The date of the theorem was there given from memory as being 1886. It should have been 1885. Lord Kelvin's letter approving of publication and remarking on the proof has since been recovered, and is dated "Nov. 12/85." [This letter has been duly shown to me as President of the Society.—S. S. HOUGH.]

† HADAMARD, J., Résolution d'une question relative aux déterminants. *Bull. des Sci. math.* (2), xvii., pp. 240–246.

HADAMARD, J., Sur le module maximum que puisse atteindre un déterminant. *Comptes-rendus . . . Acad. des Sci.* (Paris), cxi., pp. 1500–1501.

of the squares of the moduli of the elements of the r*th row of a determinant* δ, *then*

$$|\delta| \leqq s_1 s_2 s_3 \ldots$$

The original proof is neither short nor simple, the method followed being that known as "mathematical induction." From this some important conclusions are drawn, not the least interesting being those which are shown to link themselves on to a special class of determinants studied long before by Sylvester, and styled by him "inversely orthogonal determinants." *

3. In 1902 the subject acquired a still greater importance because of the intimate connection which it was found to have with Fredholm's equation.† This brought Professor Wirtinger to bestow attention on it, with the result that in 1907 he published ‡ a fresh proof of the fundamental theorem, his mode of procedure being to apply the ordinary Lagrangian rule for finding by differentiation the extreme values of a function whose variables are connected by equations of condition. This proof, though claimed to be shorter, and though having, of course, its own points of interest, cannot be said to be essentially simpler than that of Hadamard.

4. In these circumstances it seems desirable to point out, as I now propose to do, that my original method of treating the special case of the theorem is equally applicable when the elements of the determinant are complex quantities. Further, this having been done, it will readily appear that a fresh and simple presentment of the whole subject follows therefrom in a very natural way.

5. Denoting the determinant

$$\begin{vmatrix} a_1 + a_1'i & a_2 + a_2'i & a_3 + a_3'i \\ b_1 + b_1'i & b_2 + b_2'i & b_3 + b_3'i \\ c_1 + c_1'i & c_2 + c_2'i & c_3 + c_3'i \end{vmatrix} \text{ by } \mu,$$

and its adjugate by $|A_1 + A_1'i \quad B_2 + B_2'i \quad C_3 + C_3'i|$ or M, we have for $r = 1, 2, 3$,

$$\begin{aligned} \mu &= (a_r + a_r'i)(A_r + A_r'i) + (b_r + b_r'i)(B_r + B_r'i) + (c_r + c_r'i)(C_r + C_r'i) \\ &= (a_rA_r - a_r'A_r' + b_rB_r - b_r'B_r' + c_rC_r - c_r'C_r') + (a_rA_r' + a_r'A_r + b_rB_r' + b_r'B_r \\ &\qquad + c_rC_r' + c_r'C_r)i \\ &= (\Sigma a_rA_r - \Sigma a_r'A_r') + (\Sigma a_rA_r' + \Sigma a_r'A_r)i. \qquad \text{(I.)} \end{aligned}$$

* SYLVESTER, J. J., Thoughts on inverse orthogonal matrices, . . . *Philos. Magazine* (4), xxxiv. pp. 461–475; or *Collected Math. Papers*, ii., pp. 615–628.

† FREDHOLM, I., Sur une classe de transformations rationnelles. *Comptes-rendus* . . . *Acad. des Sci.* (Paris), cxxxiv., pp. 219–222, 1561–1564.

FREDHOLM, I., Sur une classe d'équations fonctionnelles. *Acta Math.*, xxvii., pp. 365–390.

‡ WIRTINGER, W., Zum Hadamardschen Determinantensatz. *Monatshefte f. Math. u. Phys.*, xviii., pp. 158–160; or *Bull. des Sci. math.* (2), xxxi., pp. 175–179.

But whatever a_r, A_r, a'_r, A'_r, ... may be

$$\begin{Vmatrix} a_r+a'_r i & b_r+b'_r i & c_r+c'_r i \\ A_r-A'_r i & B_r-B'_r i & C_r-C'_r i \end{Vmatrix} \cdot \begin{Vmatrix} a_r-a'_r i & b_r-b'_r i & c_r-c'_r i \\ A_r+A'_r i & B_r+B'_r i & C_r+C'_r i \end{Vmatrix} \geqq 0,$$

because the left-hand member is the sum of three terms, each of which is the product of a complex quantity by its conjugate. Hence

$$\begin{vmatrix} a_r^2+a_r'^2+b_r^2+b_r'^2+c_r^2+c_r'^2 & (\Sigma a_r A_r - \Sigma a'_r A'_r) + (\Sigma a_r A'_r + \Sigma a'_r A_r)i \\ (\Sigma a_r A_r - \Sigma a'_r A'_r) - (\Sigma a_r A'_r + \Sigma a'_r A_r)i & A_r^2+A_r'^2+B_r^2+B_r'^2+C_r^2+C_r'^2 \end{vmatrix} \geqq 0,$$

or

$$(\Sigma a_r^2 + \Sigma a_r'^2)(\Sigma A_r^2 + \Sigma A_r'^2) \geqq (\Sigma a_r A_r - \Sigma a'_r A'_r)^2 + (\Sigma a_r A'_r + \Sigma a'_r A_r)^2. \qquad \text{(II.)}$$

From (I.) and (II.) it follows that for $r=1, 2, 3$

$$(\Sigma a_r^2 + \Sigma a_r'^2)(\Sigma A_r^2 + \Sigma A_r'^2) \geqq |\mu|^2;$$

so that if s_r^2, S_r^2 stand for $\Sigma a_r^2 + \Sigma a_r'^2$, $\Sigma A_r^2 + \Sigma A_r'^2$, we have

$$s_1 S_1 . s_2 S_2 . s_3 S_3 \geqq |\mu|^3,$$

and $\therefore$

$$s_1 s_2 s_3 . S_1 S_2 S_3 \geqq |\mu| . |M|.$$

Now any reasons for $s_1 s_2 s_3$ being $< |\mu|$ would be equally effective in showing that $S_1 S_2 S_3 < |M|$, and would thus by multiplication entail a result at variance with that just reached. Hence finally

$$s_1 s_2 s_3 \geqq |\mu|,$$

as was to be proved.

6. If μ' be what μ becomes on writing $-i$ for i, then $s_1^2 s_2^2 s_3^2$ is evidently the diagonal term of the determinant got by multiplying μ column-wise by μ': and the result of the preceding paragraph is that $\mu\mu'$ *is not greater than its own principal diagonal term, the product-determinant being obtained by column-wise multiplication, i.e.*

$$\not> (a_1^2+a_1'^2+b_1^2+b_1'^2+c_1^2+c_1'^2)(a_2^2+a_2'^2+b_2^2+b_2'^2+c_2^2+c_2'^2)(a_3^2+\ldots).$$

Of course we could prove in similar manner that $\mu\mu'$ *is not greater than its own principal diagonal term when the product-determinant is obtained by multiplying row by row,* i.e.

$$\not> (a_1^2+a_1'^2+a_2^2+a_2'^2+a_3^2+a_3'^2)(b_1^2+b_1'^2+b_2^2+b_2'^2+b_3^2+b_3'^2)(c_1^2+c_1'^2+c_2^2+c_2'^2 + c_3^2+c_3'^2).$$

7. From § 4 it is seen that the limit $s_1^2 s_2^2 s_3^2$ which $|\mu|^2$ cannot exceed will actually be reached when for $r=1, 2, 3$

$$\begin{vmatrix} a_r+a'_r i & b_r+b'_r i \\ A_r-A'_r i & B_r-B'_r i \end{vmatrix} \cdot \begin{vmatrix} a_r-a'_r i & b_r-b'_r i \\ A_r+A'_r i & B_r+B'_r i \end{vmatrix}$$
$$+ \begin{vmatrix} a_r+a'_r i & c_r+c'_r i \\ A_r-A'_r i & C_r-C'_r i \end{vmatrix} \cdot \begin{vmatrix} a_r-a'_r i & c_r-c'_r i \\ A_r+A'_r i & C_r+C'_r i \end{vmatrix}$$
$$+ \begin{vmatrix} b_r+b'_r i & c_r+c'_r i \\ B_r-B'_r i & C_r-C'_r i \end{vmatrix} \cdot \begin{vmatrix} b_r-b'_r i & c_r-c'_r i \\ B_r+B'_r i & C_r+C'_r i \end{vmatrix} = 0.$$

This can only happen when one of the factors of each term of the left-hand member vanishes: and as the vanishing of one factor implies the vanishing of the co-factor, it can only happen when

$$\text{(X.)}\quad\begin{cases}\dfrac{a_1+a'_1i}{A_1-A'_1i}=\dfrac{b_1+b'_1i}{B_1-B'_1i}=\dfrac{c_1+c'_1i}{C_1-C'_1i}=\varsigma_1 \text{ say,}\\[2ex] \dfrac{a_2+a'_2i}{A_2-A'_2i}=\dfrac{b_2+b'_2i}{B_2-B'_2i}=\dfrac{c_2+c'_2i}{C_2-C'_2i}=\varsigma_2 \text{ say,}\\[2ex] \dfrac{a_3+a'_3i}{A_3-A'_3i}=\dfrac{b_3+b'_3i}{B_3-B'_3i}=\dfrac{c_3+c'_3i}{C_3-C'_3i}=\varsigma_3 \text{ say;}\end{cases}$$

in other words, when the elements of each column of μ are proportional to the elements of the corresponding column of M′. But when this is the case, each element of μ can be replaced by a multiple of the corresponding element of M′, with the result that we shall have

$$\mu=\varsigma_1\varsigma_2\varsigma_3.\mathrm{M}'=\varsigma_1\varsigma_2\varsigma_3.(\mu')^{3-1};$$

also, the column-by-column multiplication of μ by μ' would give

$$\begin{vmatrix}\varsigma_1\mu' & \cdot & \cdot\\ \cdot & \varsigma_2\mu' & \cdot\\ \cdot & \cdot & \varsigma_3\mu'\end{vmatrix},$$

from which the same deduction could be made.

Similarly the limit

$$(a_1^2+a_1'^2+a_2^2+a_2'^2+a_3^2+a_3'^2)(b_1^2+b_1'^2+b_2^2+b_2'^2+b_3^2+b_3'^2)(c_1^2+c_1'^2+c_2^2+c_2'^2+c_3^2+c_3'^2)$$

will be reached when the elements of each *row* of μ are proportional to the elements of the corresponding row of M′, and row-by-row multiplication will give

$$\mu\mu'=\begin{vmatrix}\varsigma'_1\mu' & \cdot & \cdot\\ \cdot & \varsigma'_2\mu' & \cdot\\ \cdot & \cdot & \varsigma'_3\mu'\end{vmatrix}.$$

Both limits will be reached, and will therefore coalesce when *all* the elements of μ are proportional to the corresponding elements of M′, and row-by-row multiplication will then give the same result as column-by-column multiplication, namely

$$\mu\mu'=\begin{vmatrix}\varsigma\mu' & \cdot & \cdot\\ \cdot & \varsigma\mu' & \cdot\\ \cdot & \cdot & \varsigma\mu'\end{vmatrix}.$$

In this event we may appropriately speak of the determinant *having a maximum value* or *being a maximum determinant.* Such is evidently possible when μ is axisymmetric or axially skew, because then the two

limits are identical. The same also is true when the elements of μ are equimodular.

8. When the elements of μ are proportional to the corresponding elements of M′, the elements of μ' are proportional to the corresponding elements of M, and therefore the moduli of the elements of μ are proportional to the moduli of the corresponding elements of M. It thus follows that when the elements of μ are proportional to the corresponding elements of M′ and the elements of μ (or M) are equimodular, then the elements of M (or μ) are equimodular also. By rationalising the denominator of each ratio in (X.), it is thus seen that when the elements of μ are proportional to the corresponding elements of M′ and are equimodular, the product of any element of μ by the corresponding element of M is constant, or, in Sylvester's language, μ is "inversely orthogonal." Also, if μ be "inversely orthogonal" and have equimodular elements, the elements must be proportional to the elements of M′, and therefore by a preceding result $|\mu|$ must have its maximum value. The problem of finding inversely-orthogonal determinants is thus closely connected with the problem of finding determinants of maximum value. Any results, therefore, obtained by Sylvester in his efforts towards a solution of the former problem deserve attention in the present connection, our scrutiny being all the closer because of the fact that his assertions are not always accompanied by proof.

9. Taking the very special form of determinant which represents the difference-product of $z, y, x, w, \ldots$, namely, the alternant $|z^0 y^1 x^2 w^3 \ldots|$, let us inquire if there be values of $z, y, x, w, \ldots$, which make it inversely orthogonal.

On multiplying each element of $|z^0 y^1 x^2 w^3|$ by the corresponding element of the adjugate determinant we obtain the array

$$\begin{array}{rrrr} yxw\,|y^0x^1w^2|, & -z\,|y^0x^2w^3|, & z^2\,|y^0x^1w^3|, & -z^3\,|y^0x^1w^2| \\ -zxw\,|z^0x^1w^2|, & y\,|z^0x^2w^3|, & -y^2\,|z^0x^1w^3|, & y^3\,|z^0x^1w^2| \\ zyw\,|z^0y^1w^2|, & -x\,|z^0y^2w^3|, & x^2\,|z^0y^1w^3|, & -x^3\,|z^0y^1w^2| \\ -zyx\,|z^0y^1x^2|, & w\,|z^0y^2x^3|, & -w^2\,|z^0y^1x^3|, & w^3\,|z^0y^1x^2|, \end{array}$$

and the condition for inverse-orthogonalism is that all the elements of this array be equal. Now the equality of the first and second elements of any row of the array is tantamount to the vanishing of Σzyx, the equality of the second and third elements to the vanishing of Σzy, and the equality of the third and fourth to the vanishing of Σz: consequently z, y, x, w must be the roots of an equation of the form $\omega^4 = a$. Again, the equality of the elements of the first *column* is tantamount to the vanishing of

$$(z^4 - y^4)/(z - y), \quad (y^4 - x^4)/(y = x), \quad (x^4 - w^4)/(x - w):$$

so that, since z, y, x, w must from the nature of the problem be all

different, the equality of the elements of the first column is tantamount to the equality of z^4, y^4, x^4, w^4—a result not different from that obtained in dealing with the rows. Our conclusion thus is that *the alternant* $|\mathrm{z}^0\mathrm{y}^1\mathrm{x}^2\mathrm{w}^3 \ldots|$ *of the* n*th order will be inversely orthogonal if* z, y, x, w, ... *be the roots of the equation* $\omega^n = a$.

10. Since a determinant that is inversely orthogonal (an *ant-orthogonant* say) continues to be so when the elements of any row or column are all multiplied by the same quantity, we may without loss of generality make $a=1$, $z, y, x, \ldots$ then becoming the nth roots of unity. Further, by taking ς to be a *primitive* nth root of unity $z, y, x, \ldots$ then become $\varsigma, \varsigma^2, \varsigma^3, \ldots$, and we see that the ant-orthogonant thus reached may be written

$$\begin{vmatrix} 1 & \varsigma & \varsigma^2 & \varsigma^3 & \cdots & \varsigma^{n-1} \\ 1 & \varsigma^2 & \varsigma^4 & \varsigma^6 & \cdots & \varsigma^{2n-2} \\ 1 & \varsigma^3 & \varsigma^6 & \varsigma^9 & \cdots & \varsigma^{3n-3} \\ \cdots & \cdots & \cdots & \cdots & \cdots & \cdots \\ 1 & \varsigma^{n-1} & \varsigma^{2n-2} & \varsigma^{3n-3} & \cdots & \varsigma^{(n-1)^2} \\ 1 & 1 & 1 & 1 & \cdots & 1 \end{vmatrix}.$$

By passing the last row over all the others the result becomes axisymmetric, and is then identical with that obtained by using Sylvester's "rule."

Since, in addition, the elements are all unimodular, the determinant reached is also, by a result of § 6, an instance of a maximum determinant.

11. If μ be Sylvester's ant-orthogonant of the nth order, it is readily found by determinant multiplication that

$$\mu^2 = n^n.(-1)^{\frac{1}{2}(n-1)(n-2)}.$$

And as we already know that

$$\mu\mu' = n^n,$$

it follows that

$$\mu = \mu'.(-1)^{\frac{1}{2}(n-1)(n-2)}.$$

It may also be worth noting that the complementary minor of the first element is symmetric with respect to both diagonals.

12. If μ_r, μ_s be maximum determinants of the rth and sth orders respectively, and μ_{rs} the maximum determinant of the (rs)th order formed according to Sylvester's second rule, then

$$\mu_{rs} = (\mu_r)^s(\mu_s)^r.$$

13. It would, of course, be unwise to conclude without further investigation that the determinant reached in § 9 is the only n-line orthogonant. As an illustration, let us inquire whether the axisymmetric determinant

$$\begin{vmatrix} 1 & 1 & 1 & 1 \\ 1 & a & b & c \\ 1 & b & d & e \\ 1 & c & e & f \end{vmatrix}$$

can only be inversely orthogonal when

$$a,\, b,\, c,\, d,\, e,\, f = -i,\ (-i)^2,\ (-i)^3,\ (-i)^4,\ (-i)^6,\ (-i)^9,$$
$$= -i,\ -1,\ i,\ 1,\ -1,\ -i.$$

To ensure inverse-orthogonalism the products which must be equal are

$$\begin{array}{ll} adf + 2bce - c^2d - b^2f - e^2a, & b(-bf - c - e + b + f + ce), \\ -df - ce - be + cd + bf + e^2, & c(be + c + d - b - e - cd), \\ bf + c^2 + ae - bc - af - ce, & d(af + 2c - a - f - c^2), \\ -be - bc - ad + b^2 + ae + cd, & e(-ae - c - b + a + e + bc), \\ a(df + 2e - d - f - e^2), & f(ad + 2b - a - d - b^2)\,; \end{array}$$

and since the equality of the 8th and 10th products is tantamount to the equality

$$\frac{d}{f} = \frac{2b - b^2 - a}{2c - c^2 - a},$$

it is evident that the said two products will be equal if we make $c = b$ and $f = d$. Doing this we next see that the equality of the 3rd and 6th products is tantamount to

$$a(e-d) = b^2(e-d)\,;$$

and, since the taking of $e = d$ is excluded by the fact that this would cause both products to vanish, we are forced, in order that the two may be equal, to take $a = b^2$. It will be found, however, that this taking of $a,\, c,\, f = b^2,\, b,\, d$ makes certain others of the products equal—that, in fact, there only remain five to be dealt with, these now taking the forms

$$b^2(d-e)(d+e-2), \quad -(d-e)(d+e-2b), \quad (d-e)b(1-b),$$
$$d(b-1)(bd+d-2b), \quad -e(b-1)(be+e-2b).$$

Recalling again the fact that none of the factors here visible can be allowed to vanish, we see that the equality of the first three products is tantamount to

$$d + e = 2b(b+1)/(b^2+1) = b^2 + b,$$

and that therefore the said products can only be properly equal when

$$b = -1, \quad e = -d.$$

As, however, their common value is then $-4d$, and as the 4th and 5th products have this value also, our final result is that

$$\begin{vmatrix} 1 & 1 & 1 & 1 \\ 1 & 1 & -1 & -1 \\ 1 & -1 & d & -d \\ 1 & -1 & -d & d \end{vmatrix}$$

is inversely orthogonal whatever d *may be, the product of any element by its*

co-factor in the determinant being -4d, *and the value of the determinant itself being consequently* -16d.*

When d is a complex quantity whose modulus is 1, the determinant is both inversely orthogonal and equimodular, and therefore is a determinant of maximum value. This was first pointed out by Hadamard.

14. If in addition to requiring the elements of μ to be unimodular we insist on them being real—in other words, if we seek to construct maximum determinants whose elements are $+1$ or -1—we soon find that the problem is soluble only for certain orders of determinants. We can show, however, that *if a solution be obtained for order* r *it is easy to give a solution for order* 2r. For the rows of the r-line determinant being A, B, C, ... we know that

$$\begin{array}{rrr} AB=0, & AC=0, & AD=0, \ldots\ldots \\ & BC=0, & BD=0, \ldots\ldots \\ & & CD=0, \ldots\ldots \\ & & \ldots\ldots \end{array}$$

and this being the case the $2r$-line determinant whose rows are

$$(A, A), \quad (A, -A), \quad (B, B), \quad (B, -B), \quad (C, C), \quad (C, -C), \ldots\ldots$$

has evidently the same property. Thus, the determinant for the 2nd order being

$$\begin{vmatrix} 1 & 1 \\ 1 & -1 \end{vmatrix},$$

the determinant for the 4th order is

$$\begin{vmatrix} 1 & 1 & 1 & 1 \\ 1 & 1 & -1 & -1 \\ 1 & -1 & 1 & -1 \\ 1 & -1 & -1 & 1 \end{vmatrix},$$

which agrees with the result of § 13.

The determinants of order 2^m thus obtainable are all axisymmetric.

15. Hadamard's 12-line determinant of this kind has also a latent axisymmetry which it is preferable to put in evidence. If we denote a row of three elements by the place-numbers of those which are negative, thus

$$1 \quad 1 \; -1 \text{ by } 3, \quad -1 \quad 1 \; -1 \text{ by } 13, \quad \ldots\ldots$$

* Besides the solution obtained in this paragraph there are at least two others, the set of three being

$$\begin{aligned} a, b, c, d, e, f &= 1, \; -1, \; -1, \; x, \; -x, \; x, \\ &= x, \; -x, \; -1, \; x, \; -1, \; 1, \\ &= x, \; -1, \; -x, \; 1, \; -1, \; x. \end{aligned}$$

They are not, however, really different.

the axisymmetric determinant in question is

.	.	.	.
.	.	123	123
.	123	.	123

3	12	23	1
3	13	12	3
3	23	13	2

2	23	12	1
2	12	13	3
2	13	23	2

23	1	1	12
23	3	3	13
23	2	2	23.

This notation is very useful in that, if we wish to test whether the product of two different rows vanishes (as every such product ought), we have only to count the number of different digits in each of the four sections of the two rows; thus, in the case of the rows

.	123	.	123
23	2	2	23

there are 2 corresponding digits different in the first section, 2 in the second, 1 in the third, and 1 in the fourth—that is to say, 6 altogether, which give -1 on performing multiplication, thus making the product $6-6$. Similarly in the case of the last two rows the like number is $0+2+2+2$.

16. On the other hand, Hadamard's 20-line determinant appears to be essentially unsymmetric. As the result of a fresh investigation, in which axisymmetry was steadily kept in view, the following has been reached—

.	.	.	.
.	.	12345	12345
.	12345	.	12345
45	145	135	24
45	245	234	15

34	123	345	45
35	123	123	12
3	1245	1245	3
345	34	24	234
345	35	15	135

24	234	125	14
25	235	134	34
245	12	45	123
25	134	235	35
24	135	124	25
......	......	......	......
235	25	25	245
234	24	13	235
23	345	345	12
234	15	23	134
235	14	14	145.

Here the axisymmetry is first departed from in the case of the elements in the places (9, 11), (11, 9).

17. When the elements of μ are real we see from (X.) of § 7 that μ will simultaneously reach its row-by-row limit and its column-by-column limit when

$$\begin{aligned} & \frac{a_1}{A_1} = \frac{b_1}{B_1} = \frac{c_1}{C_1} \\ = & \frac{a_2}{A_2} = \frac{b_2}{B_2} = \frac{c_2}{C_2} \\ = & \frac{a_3}{A_3} = \frac{b_3}{B_3} = \frac{c_3}{C_3}\,; \end{aligned}$$

in other words, when the elements of μ are proportional to the corresponding elements of the adjugate determinant. This property, we know, is possessed by an orthogonant, the common ratio, in the case where the name orthogonant is strictly applicable, being the orthogonant itself. A set of interesting examples is to be found in the series of skew determinants*

$$\begin{vmatrix} a & b \\ -b & a \end{vmatrix}, \quad \begin{vmatrix} a & b & c & d \\ -b & a & d & -c \\ -c & -d & a & b \\ -d & c & -b & a \end{vmatrix}, \quad \begin{vmatrix} a & b & c & d & e & f & g & h \\ -b & a & d & -c & f & -e & -h & g \\ -c & -d & a & b & g & h & -e & -f \\ -d & c & -b & a & h & -g & f & e \\ -e & -f & -g & -h & a & b & c & d \\ -f & e & -h & g & -b & a & -d & c \\ -g & h & e & -f & -c & d & a & -b \\ -h & -g & f & -e & -d & -c & b & a \end{vmatrix}, \ldots$$

* Another form of the second of the series, which looks essentially different, is not really so, the one O'_2 being obtainable from the other O_2 by altering the signs of the 1st row and 1st column, and then changing columns into rows. As regards the third of the series, its first quarter is O'_2, the quarter to the right is of the same type as O_2 but with the signs of three rows changed, the last quarter is O'_2, and the remaining quarter is of the same type as O'_2 with the signs of one row changed: other forms, however, are obtainable, the first quarter being always O_2 or O'_2, and all the other elements being determinable when the signs of the places (2, 5), (2, 7), (3, 5) are known.

or, say, $O_2, O_4, O_8, \ldots$, the second of which has for its adjugate

$$\begin{vmatrix} a\Sigma a^2 & b\Sigma a^2 & c\Sigma a^2 & d\Sigma a^2 \\ -b\Sigma a^2 & a\Sigma a^2 & d\Sigma a^2 & -c\Sigma a^2 \\ -c\Sigma a^2 & -d\Sigma a^2 & a\Sigma a^2 & b\Sigma a^2 \\ -d\Sigma a^2 & c\Sigma a^2 & -b\Sigma a^2 & a\Sigma a^2 \end{vmatrix},$$

and for its attained upper limit $(\Sigma a^2)^2$.

18. Bringing together the results of §§ 7, 17, we note that a maximum determinant with *complex* elements is an *ant-orthogonant* only when the elements are equimodular, and that a maximum determinant with *real* elements is always an *orthogonant*. In the latter case, however, it has to be noticed that if the only elements permissible be $+1$ and -1 the distinction between orthogonant and ant-orthogonant disappears, because then

$$a_{rs}A_{rs} = a_{rs}^2\frac{A_{rs}}{a_{rs}} = \frac{A_{rs}}{a_{rs}}.$$

CAPE TOWN,
Dec. 28, 1908.

[19. Added 21/1/09.] As the last step of the reasoning in §5 may not carry conviction to some, I append, on Mr. Hough's suggestion, another proof of the most direct and simple character:—

THEOREM.—The row-by-row product of two determinants whose corresponding elements are complex conjugates is not greater than its own principal diagonal term.

PROOF.—Let the two determinants and their product be

$$\begin{vmatrix} a_1 & a_2 & a_3 & \ldots \\ b_1 & b_2 & b_3 & \ldots \\ c_1 & c_2 & c_3 & \ldots \\ \ldots & \ldots & \ldots & \ldots \end{vmatrix}, \quad \begin{vmatrix} a_1' & a_2' & a_3' & \ldots \\ b_1' & b_2' & b_3' & \ldots \\ c_1' & c_2' & c_3' & \ldots \\ \ldots & \ldots & \ldots & \ldots \end{vmatrix}, \quad \begin{vmatrix} (aa') & (ab') & (ac') & \ldots \\ (ba') & (bb') & (bc') & \ldots \\ (ca') & (cb') & (cc') & \ldots \\ \ldots & \ldots & \ldots & \ldots \end{vmatrix}.$$

Then in the first place it is clear that

$$\begin{vmatrix} (aa') & (ab') \\ (ba') & (bb') \end{vmatrix} \ngtr (aa')(bb') \qquad \text{(I.)}$$

because (ab'), (ba') are complex conjugates. In the second place, from a well-known property of determinants we have

$$\begin{vmatrix} (aa') & (ab') & (ac') \\ (ba') & (bb') & (bc') \\ (ca') & (cb') & (cc') \end{vmatrix} = \begin{Vmatrix} \begin{vmatrix} (aa') & (ab') \\ (ba') & (bb') \end{vmatrix} & \begin{vmatrix} (aa') & (ac') \\ (ba') & (bc') \end{vmatrix} \\ \begin{vmatrix} (aa') & (ab') \\ (ca') & (cb') \end{vmatrix} & \begin{vmatrix} (aa') & (ac') \\ (ca') & (cc') \end{vmatrix} \end{Vmatrix} \div (aa'),$$

∴ by (I.)

$$\ngtr \begin{vmatrix} (aa') & (ab') \\ (ba') & (bb') \end{vmatrix} \cdot \begin{vmatrix} (aa') & (ac') \\ (ca') & (cc') \end{vmatrix} \div (aa'),$$

and again by (I.)

$$\ngtr (aa')(bb')(cc'). \qquad \text{(II.)}$$

Similarly P, Q, R, S being the co-factors of the elements (dd'), (dc'), (cd'), (cc') in the four-line determinant we have

$$\begin{vmatrix} (aa') & (ab') & (ac') & (ad') \\ (ba') & (bb') & (bc') & (bd' \\ (ca') & (cb') & (cc') & (cd') \\ (da') & (db') & (dc') & (dd') \end{vmatrix} = \begin{vmatrix} \mathrm{P} & \mathrm{Q} \\ \mathrm{R} & \mathrm{S} \end{vmatrix} \div \begin{vmatrix} (aa') & (ab') \\ (ba') & (bb') \end{vmatrix},$$

$\therefore$ by (I.)

$$\not> \mathrm{PS} \div \begin{vmatrix} (aa') & (ab') \\ (ba') & (bb') \end{vmatrix},$$

$\therefore$ by (II.)

$$\not> \frac{\begin{vmatrix} (aa') & (ab') \\ (ba') & (bb') \end{vmatrix} \cdot \begin{vmatrix} (aa') & (ac') \\ (ca') & (cc') \end{vmatrix}}{(aa')} \cdot (aa')(bb')(dd') \div \begin{vmatrix} (aa') & (ab') \\ (ba') & (bb') \end{vmatrix},$$

and again by (I.)

$$\not> (aa')(bb')(cc')(dd').$$

And so generally.

REMARKS ON SOME EXPERIMENTS WITH SNAKE-VENOM.*

By Dr. Walter Frei.

(Communicated by Dr. A. Theiler, C.M.A., F.R.S.S.Af.).

(Read March 17, 1909.)

The experiments were undertaken: (1) In order to ascertain whether certain South African snakes, about which there were doubts till now, are harmless or poisonous (specially Opistoglypha): (2) To study the pathological-anatomical lesions provoked by the venom of South African snakes.

1. Aglypha.†

An emulsion of both maxillary glands in normal saline solution of *Boodon lineatus*, the brown house-snake, was injected subcutaneously into a rabbit and a guinea-pig.

Result.—No local, nor general pathological alterations appeared.

With another portion of the emulsion experiments for hæmolysis were tried with original human blood and horse blood, previously washed with normal saline solution.

No hæmolysis took place within 8 hours' stay in the incubator.

2. Opistoglypha.

(*a*) A specimen of *Leptodira hotambœia*, red-lip snake, was forced to bite the ear of a guinea-pig.

As no symptoms made their appearance, the snake was killed and an emulsion of both maxillary glands injected into the same guinea-pig subcutaneously. After 5½ hours the guinea-pig was found dead with its mouth full of forage.

* Paper read before the Transvaal Biological Society, October 26, 1908.

† From a toxicological standpoint the classification of the snakes in: 1. Aglypha, 2. Opistoglypha, 3. Proteroglypha, 4. Solenoglypha, is the most satisfactory one, as will be shown in the course of the paper.

Post Mortem.—Blood partially coagulated. Heart in diastole. Endocard normal, lungs normal, stomach filled, normal; all other abdominal organs without any lesions.

Conclusion.—The venom of *Leptodira hotambœia*, or, better, its effective constituent, must have been absorbed by the nervous system.

In another instance an emulsion of the maxillary glands of the red-lip snake did not provoke any sign of illness, when injected under the skin of a rabbit. The venom appears therefore to be more virulent for guinea-pigs than for rabbits, if the snake itself were under normal conditions.

(*b*) *Tarbophis semiannulatus.* An emulsion of both maxillary glands of a young specimen produced no pathological appearances after subcutaneous injection into a small guinea-pig.

(*c*) An emulsion of the right maxillary gland of *Trimerorhinus tritæniatus* (Günther), striped "schaap-steekker," subcutaneously injected, killed a small guinea-pig (weight 150 gr.) in 15 minutes.

Symptoms.—Salivation, masticatory movements, secretion from the lachrymal glands.

Post Mortem.—Nothing particular.

(*d*) *Aparallactus capensis.* Black-headed snake. An emulsion of the maxillary glands, subcutaneously injected into a small guinea-pig, produced no symptoms of illness.

(*e*) *Psamophis sibilans.* Hissing sand-snake. An emulsion of maxillary glands of 3 individuals injected subcutaneously into (1) a frog (*Rana delalandi*); (2) a small rabbit; and (3) a small guinea-pig (weight 310 gr.). The frog and the rabbit did not become sick at all. The guinea-pig showed no symptoms for 50 minutes. After this time its respiration became quick and spasmodic. The animal laid down; cramps of the hind legs and retarded respiration were the final symptoms. Death occurred 1 hour after injection.

Post Mortem.—No lesions.

3. Proteroglypha.

(*a*) Five drops of venom from *Dendraspis angusticeps*, Mamba, were diluted with 1·5 c.c. 0·9 per cent. solution of NaCl, and the mixture was divided into 3 parts and injected into 3 rabbits (2 subcutaneously, 1 partially subcutaneously, partially intravenously).

Symptoms.—First rabbit. Quick jerky respiration, extension of the head, salivation, discharge of big white tears, cramps of the legs, paralysis; death after 30 minutes.

Second rabbit. Extension of the head, abundant salivation, jerky respiration, ataxy of hind quarters, stupid running forwards, cramps of the legs, paralysis; death after 15 minutes.

Third rabbit. Accelerated respiration, discharge of white tears, salivation, slight prolapsus vaginæ, output of white urine, cramps, paralysis; death after 25 minutes. Microscopical examination of the saliva: No leucocytes but small drops of a yellow liquid, like an oil.

Post Mortem.—In all three rabbits: Hæmorrhagic infiltration of the place of injection, blood thin somewhat hæmolytic; no abnormalities in the internal organs.

(*b*) *Naia haie.* Cobra. One drop of poison, dried out for 2 days, was redissolved in 2 c.c. normal saline solution and injected under the abdominal skin of a rabbit.

Symptoms.—Uneasiness; accelerated, sometimes jerky respiration for the first 15 minutes; emission of urine. The animal then became quiet and died 35 minutes after injection without any additional symptoms.

Post Mortem.—Blood dark; heart in diastole; ecchymoses on left endocardium, right endocardium normal; lungs collapsed, œdematous; hæmoglobin-stained liquid in peritoneal cavity; omentum, mesentery, and serous coat of small intestines injected. One Peyer's patch of cœcum swollen and injected, other abdominal organs normal. Urinary bladder slightly injected, urine normal. Very likely the dose was not large enough to produce more distinct symptoms.

4. Solenoglypha.

(*a*) A specimen of *Causus defilippi*—night-adder—was allowed to bite into the hind leg of a guinea-pig. The latter showed uneasiness and spasmodic respiration, but was normal again after an hour's time.

A similar second experiment with both the same, snake and guinea-pig, was without result. The night-adder is known as a poisonous snake.

(*b*) *Bitis orietans.* Puff-adder. The poison was squeezed out and 1½ drops of it injected—

1. Under the abdominal skin of a guinea-pig.

Symptoms.—Uneasiness, whimpers from time to time; the animal was paralytic 2 hours after injection, and was found dead 5½ hours later.

Post Mortem.—Necrosis of the skin on the spot of the injection, diffuse dark red hæmorrhagic infiltration of the skin and subcutaneous tissue and musculature of the abdomen. Blood thin, hæmolytic. Uterus pregnant; uterine liquid, stained with hæmoglobin.

2. A rabbit was injected, like the guinea-pig, with 1·5 drops of the poison of the same puff-adder. Only local symptoms were seen, consisting in a necrosis of the skin where the injection had been made, about 3 cm. in diameter. The wound was not completely healed after 12 days.

This venom was hæmolytic *in vitro* for horse blood as is proved by the following experiments :—

Tube Number	I.	II.	III.	Control.
0·9 per cent. NaCl	1 c.c.	1 c.c.	1 c.c.	1 c.c.
Snake-poison diluted with 0·9 per cent. NaCl 1:4	15 drops	20 drops	20 drops	0
Blood, 5 drops	washed horse blood	unwashed horse blood	unwashed ox blood	unwashed ox blood
Result after 45 minutes at 37° Cels.	0	0	0	0
Result after 6 hours at 25° Cels.	0	complete hæmolysis	distinct hæmolysis	0
Addition of horse serum	1 c.c.	—	—	—
Result after 3 hours at 37° Cels.	almost complete hæmolysis	—	—	—

Snake-venom diluted with NaCl 1 : 4.

In each tube 1 c.c. NaCl solution and 0·5 c.c. 5 per cent. emulsion of ox blood 3 times washed.

Tube Number	I.	II.	III.	IV.	V.	Control.
Poison solution	3 drops	5 drops	8 drops	10 drops	12 drops	0
Result after 8 hours' delay at room temp.	0	0	0	0	0	0
Follows	centrifug.	centrifug.	—	—	centrifug.	—
Added to the liquid unwashed ox blood	0·5 c.c.	0·5 c.c.	—	—	0·5 c.c.	—
Result after 3 hours at 37° Cels.	0	0	—	—	0	—
Added ox serum	to the deposit 1 c.c.	to the deposit 1 c.c.	1 c.c.	1 c.c.	to the deposit 1 c.c.	—
Result after 3 hours at 37° Cels.	0	0	0	0	0	—

Snake-venom diluted with NaCl 1 : 4.

Each tube contains 1 c.c. NaCl + 0·5 c.c. per cent. emulsion of horse blood 3 times washed.

Tube Number	I.	II.	III.	IV.	V.	Control.
Venom solution	3 drops	5 drops	8 drops	10 drops	12 drops	0
Result after 8 hours' delay at 25° Cels.	0	0	0	0	0	0
Follows	—	—	centrifug.	centrifug.	—	—
Added unwashed horse blood to the liquid	—	—	0·5 c.c.	0·5 c.c.	—	—
Result after 3 hours at 37° Cels.	—	—	almost complete hæmolysis	almost complete hæmolysis	—	—
Added horse serum	1 c.c.	1 c.c.	1 c.c. to the deposit	1 c.c. to the deposit	1 c.c.	—
Result after 3 hours at 37° Cels.	slight hæmolysis	slight hæmolysis	distinct hæmolysis	complete hæmolysis	distinct hæmolysis	—

These experiments demonstrate :—

(*a*) That original blood is easier dissolved by the puff-adder poison than previously washed blood; that is to say, blood corpuscles without serum.

(*b*) That horse blood is more susceptible than ox blood.

(*c*) That the venom is absorbed by the horse-blood corpuscles and emphasises itself after addition of horse serum.

Hence the venom alone has no hæmolytic power. It contains a com-

ponent, which, associated with a serum component (horse), dissolves horse-blood corpuscles. According to numerous experiments with other snake-poisons the serum component in question is lecithine, and there is very little doubt that also in our experiments lecithine acts as an activator for the hæmotoxic component of the puff-adder poison, forming with it the hæmolytic lecithide.

3. 0·3 c.c. puff-adder poison were injected subcutaneously into a horse 3081, and the following *symptoms* recorded :—

Uneasiness; discharge from nostrils; pulse 15 minutes after injection, 60; respiration, 70; 35 minutes after injection, pulse 60; respiration, 38. Enormous swelling of the place of injection. Trembling of pectoral, gluteal and caudal muscles. The temperature rose 6 hours after injection up to 105·0, but fell within an hour to 102·4. The horse died 9 hours after injection.

Post Mortem.—Enormous swelling on left side, where inoculation took place, extending from base of neck and pectoral muscles to the last rib, corresponding with œdematous and hæmorrhagic infiltration of subcutaneous and intermuscular tissues in these regions. Liquid in pleural cavity and pericardium slightly increased. Hæmorrhagic spots on anterior side of diaphragm, on pericardium and left costal pleura, ecchymoses on visceral pleura, hæmorrhagic infiltration of mediastinal glands, ecchymoses on epicardium and both endocardia. Liver khaki-coloured, with numerous hæmorrhages in the capsula. Spleen and kidneys pale. Mucosa of urinary bladder showed patchy hyperæmia and petechieæ; urine normal. Bone marrow of left radius and femur normal. Hæmorrhagic infiltration of perispinal tissue near seat of inoculation.

Résumé.

With regard to the question which of the doubtful South African snakes, chiefly Opistoglypha, are poisonous or harmless, only a preliminary answer can be given, as the experiments are not yet numerous enough. Especially the experiments which gave negative results have to be repeated.

Boodon lineatus (Aglypha) proved in two instances to be harmless, as was to be expected. The experiments with emulsions of maxillary glands from Opistoglypha gave the following results :—

Leptodira hotambœia was poisonous in one, harmless in another case.

Tarbophis semiannulatus was harmless (in one instance).

Trimerorhinus tritæniatus proved to be poisonous (in one case).

Aparallactus capensis was harmless (in one case).

Psamophis sibilans was poisonous in one, harmless in two instances, one of the latter being an amphibian.

That is to say, three of five snakes belonging to the family Opistoglypha are apparently not harmless.

A reasonable objection might be made against the method of inoculating the maxillary gland substance itself instead of their secretion, namely, that emulsions of any mammalian organ have toxic effect on mammalian organisms, and that reptilian albuminoids must be still more toxic. Indeed, control experiments with other organs of the snakes in question have to be made; the best proof as to whether a snake is harmless or poisonous is certainly the injection of the secretion of the maxillary glands.

But, on the other hand, it is not very likely that an emulsion of maxillary glands would provoke symptoms so similar to those that signify a real snake-poison, and it is not easy to understand why every emulsion had not a toxic effect (emulsion from *Boodon* and *Tarbophis* were completely without effect).

Finally, I should like to mention as a corroboration of this opinion that the Opistoglyphal snakes, the emulsions of which were poisonous, have longer grooved teeth than those yielding a harmless gland emulsion.

The *symptoms* in all animals injected with the poisons of Opistoglypha, Proteroglypha, and Solenoglypha were about the same, namely as follows:—

Uneasiness; accelerated, sometimes spasmodic respiration; salivation; cramps; finally paralysis and retarded respiration antecedent to death.

That is to say, the first symptoms are expressions of nervous excitement, finally followed by paralysis. In this respect the symptoms resemble those of rabies and narcotics.

It would be very useful in practice to be able to point out the family to which a snake belongs from the clinical symptoms produced by its poison. As it has to be deduced from numerous experiments in other countries, the antisera against South Africa snake-venom would be specific for each of the various families of snakes. In a concrete case of snake-bite the knowledge of the zoological classification of the snake would determine which serum has to be applied for the treatment.

As only the adequate or specific serum is efficacious, the selection of this serum (among a number of snake antisera) for the application must be of great importance.

According to our experiments, there is a difference between the symptoms of Opistoglypha venom and Solenoglypha venom, namely, the poison of Opistoglypha produced no local alterations or very slight ones, while the Solenoglypha poison caused hæmorrhagic infiltrations, swellings, and necrosis of the skin.

The difference in the *post-mortem lesions* produced by the three venomous families of snakes are the following:—

1. *Opistoglypha.*—No pathological anatomical alteration at all; the poison is a simple one, a mere *neurotoxine.*

2. *Proteroglypha.*—Local hæmorrhages, slight hæmolysis; the poison consists of two components—a *neurotoxine* and a *hæmotoxine.*

3. *Solenoglypha.*—Local hæmorrhages and necrosis, hæmolysis. Besides the *neurotoxine* there is a *strong hæmotoxine*, which dissolves red blood corpuscles. It is yet doubtful whether the necrosis is due to a special component of the poison.

Perhaps the hæmolysine is able to destroy besides erythrocytes other cells in the same manner as hæmolytic sera, which at the same time cause necrosis.

With regard to the question as to whether snakes themselves are susceptible to snake-poisons, we made one experiment.

0·25 c.c. original poison of *Bitis arietans* were injected partially subcutaneously, partially intraperitoneally into a large ♀ specimen of *Ablabophis rufulus*—water-snake—which is non-poisonous.

Symptoms.—Besides a slight excitement nothing particular the first day. The next day, however, the places of injection were swollen with hæmorrhagic margins, and the epidermis came off; scales mollified. The snake died the following night, *i.e.*, about 36 hours after injection.

Post Mortem.—The symptoms were the same as in mammalians, namely, infiltration of cutis and costal muscles round the places of injection, hæmorrhagic spots on fat bodies and on the intestines. Liver and kidneys injected. Blood in heart not coagulated-hæmolytic.

The water-snake possesses therefore not absolute but considerable immunity against the poison of the puff-adder, compared with the horse that received practically the same doses—the weight of the horse is about 500 times greater, and it died within 9 hours.

I here take the opportunity of thanking Dr. L. H. Gough for his most valuable assistance in carrying out these experiments.

NOTE ON A *CŒNURUS* OF THE DUIKERBOK.

By Lewis H. Gough, Ph.D.

(Read March 17, 1909.)

(With 1 Fig. in text.)

A specimen of a *Cœnurus*, evidently closely related to, if not belonging to *Cœnurus serialis* Railliet was found embedded in the muscles between the scapula and the vertebral column of a Duikerbok (*Cephalophus grimmi* Linn.) from Cradock, C.C., which died in the Zoological Gardens of Pretoria on December 22, 1908.

In view of the small number of intramuscular *Cœnurus* recorded from ruminants, and as the worm differs from *Cœnurus serialis* in some respects, I here give a short account of it :—

The adventitious or host coat of the cyst was intimately connected with muscle fibres, rather irregular in shape, and measured 9 cm. by 3 cm.

The cyst itself was of the same size, and of approximately the same shape, but possessed several diverticula and more or less deep constrictions and filled the outer envelope entirely. There were no daughter cysts.

Seven groups of scolices could be seen through the membrane of the cyst, up to 60 scolices forming a group. These groups were not confined to any one zone of the cyst, but were irregularly distributed. In some of the groups the scolices had a tendency towards serial arrangement, in others they were arranged in no definite order.

The scolices were almost all on the inner surface of the cyst—a few were, however, everted on the outer surface.

Externally the position of the scolices was marked by a slight unevenness, best seen in reflected light.

The heads were all very nearly of one size, but differed in maturity; their average size was about $1\frac{1}{4}$ by 1 mm., the scolex proper only measuring $\frac{2}{3}$ mm. wide, by $\frac{1}{2}$ mm. long, neck about $\frac{1}{2}$ mm. long.

Although almost all the scolices were firmly planted on the walls of the cyst, a few were attached to it by a thin pedicle.

The number of hooks is 26–31; they are arranged in two rows, the hooks of the two rows differing in size and shape.

The hooks of the minor row measure in a mature scolex: total length 128 μ, measured in a straight line from tip to tip, length of blade from tip to notch separating handle from blade 88 μ, length of handle 40 μ.

The guard projects from hook 20 μ, and is bifid, the distance apart of the right and left tips of the guard 32 μ.

In a less mature scolex: total length 85 μ, handle 12 μ, guard 16 μ, scarcely bifid.

The hooks of the major row measure in a mature scolex: total length 168 to 176 μ, blade 120 μ, handle 48–56 μ, guard simple, projecting 28–32 μ.

In the less mature scolex already referred to the measurements were: total length 176 μ, length of blade 112 μ, handle 56 μ, guard 28 μ.

Apparently the larger hooks arrive at their full size sooner than the lesser ones.

The diameter of the crown of hooks is about 430 μ. There are four suckers, whose diameter is about 250–320 μ.

The calcareous bodies are very densely arranged in the neck; they measure on the average 10–12 μ in diameter.

The cysts evidently belong to the type of *Cœnurus serialis* Railliet, differing from *Cœnurus cerebralis* Rud. by the bifid guard of the minor hooks, and the seat in the muscles.

S. H. Gaiger described in 1907 two cases of *Cœnurus serialis* Railliet in goats in India, and was able to rear adults for the identification of the species. Apart from his cases, the worm has always been found in rodents, except one case in equines (Stiles).

The worm under review differs, however, in some respects from the typical *C. serialis.*

Cœnurus serialis Railliet Traité, p. 257.	*Cœnurus serialis* Gaiger.	*Cœnurus* sp.
Often forming daughter cysts.	A tendency to form daughter cysts.	No daughter cysts.
Of the size of a hen's egg.	Size of an egg ($6\frac{1}{2}$ cm.) from figures.	9 cm. and 3 cm.
Length of major hooks, 137–157 μ.	160 μ.	168–176 μ.
Length of major hooks, 85–112 μ.	115 μ.	128 μ.
Groups of scolices confined to a particular zone.	(?)	Groups scattered.

It will be seen that apart from the difference in size of the cysts, the size of the hooks of both rows is distinctly larger in my specimens than in either the tpyical specimens as given by Railliet, or in Gaiger's specimens. This difference is great enough to justify hesitation in placing the worm from the Duiker in the same species; it may be found to belong to a third species of *Cœnurus*, or else to be a variety of *C. serialis.*

THE EVOLUTION OF THE RIVER SYSTEM OF GRIQUALAND WEST.*

By Alex L. du Toit, B.A., F.G.S.

(Read March 17, 1909.)

(With Map. Plate XXV.)

The present river system of Griqualand West and the adjoining Transvaal and Orange River Colony has proved to possess a history probably more complex than any other yet described from South Africa, and one that can be traced back clearly to a geological period considerably more remote. The factors concerned in the development of the drainage lines have been so varied and uncommon that, although much still remains to be learnt concerning this and the adjoining area, the author has thought that it might be well to put on record a general account of the evolution of the drainage system of this portion of Cape Colony.

The Dry Harts River, flowing nearly due south from Vryburg in a narrow but widening valley, joins at Taungs the Harts River, which drains the south-western corner of the Transvaal, there acquiring a more south-westerly trend. The Vaal River possesses a course nearly parallel to it from Warrenton to Riverton, but makes a bend at Barkly West, and at Delports Hope enters the Harts River at right angles.

The Vaal River Valley from this point onwards is a continuation of that of the Harts, and receives the Riet and Orange Rivers from the east, also at right angles. The latter changes its course to south-west—a direction which it maintains as far as Prieska, and is joined by the Brak River from the south a little above the point where it resumes its north-westerly direction of flow.

There is thus one continuous valley extending with a gradual curve from Vryburg to Prieska, a distance of 235 miles, and receiving from the left the Harts, Vaal, Riet, Orange, and Brak Rivers.

This valley, which, strangely enough, possesses no single name applicable throughout its entire length, although geographically so entitled, will in what follows be styled the *Kaap Valley*, from the fact

* Published with the permission of the Geological Commission.

that for three-fourths of its length it is bounded on its right-hand side by the escarpment of the Kaap Plateau.

Considering now the geological character of the area, we find rocks belonging to the extremely ancient pre-Cape formations which are, through denudation, appearing from beneath the mantle of Karroo deposits by which they had been covered in Permian and Triassic times. This erosion has revealed a land surface with a drainage system belonging to late Palæozoic times, of which the Kaap Valley formed an important branch. The evolution of the modern drainage system has to a very considerable degree been influenced and modified by its superposition upon that of the palæozoic continental mass.

The matter acquires a still higher interest in view of the fact that this land surface was intensely glaciated and its minor features considerably modified by a vast ice-sheet towards the close of the Carboniferous epoch.

The area under consideration is well situated for the elucidation of the various problems involved, for further to the east and south the old land surface becomes buried beneath younger sediments, while to the north and west the denudation has been somewhat prolonged and superficial deposits frequently conceal the formations, principally in the valleys.

Physical and Geological Features.

A notion of the physiography of the area under consideration will be gathered from the following account and from the map attached. The most striking feature is the vast Kaap Plateau, built up of the nearly flat-lying limestones, dolomites, and cherts of the Campbell Rand series. The edge of the plateau maintains an altitude of about 4,000 feet above sea-level from Vryburg down to near Read's Drift—a distance of 160 miles—the vertical fall into the valley below increasing within that distance from 150 to 800 feet. From its edge the plateau rises gradually and uniformly towards a chain of hills with curiously rounded outlines, known as the Asbestos Mountain or Griqua Town Hills, which extend from Prieska to beyond Kuruman in a curve convex to the east. The highest point is attained on the boundary between Kuruman and Barkly West, namely, 6,070 feet, and the contours of the Kaap Plateau form even curves round this central point. North of this the surface falls towards the Kuruman River.

West of the Asbestos Mountains there is rather rugged country with numerous valleys, frequently sandy bottomed, culminating in the quartzite ridges of the Langsbergen with a nearly northerly trend. The drainage from this quarter is conducted into the Orange River. South of the Orange River the same bended jaspers that compose the Asbestos Mountains form the Doornberg, a chain of steep-sided hills with similar

smooth outlines stretching south-eastwards parallel to the river to a point a little north of Omdraai's Vlei. The altitude of the Doornberg exceeds 4,200 feet at several points.

Towards Kenhardt is another tract of elevated country trending, like the Doornberg, north-west and south-east, but not quite so high, and composed chiefly of Kheis quartzite and mica-schists. South-east of the areas of high ground referred to is a wide undulating tract formed principally by the Dwyka series, the basal portion of which, resting unconformably upon the underlying formations, is the celebrated Dwyka conglomerate or "tillite" of glacial origin. In this area, composed of material of late Palæozoic age, are numerous inliers of older rocks, principally the volcanics of the Ventersdorp system. These inliers form, with rare exceptions, ground higher than the surrounding tillite, and obviously represent the ridges of the pre-Karroo land surface, the troughs and valleys in most cases remaining buried beneath the glacial deposits.

Such inliers are found west and south of the Doornberg, and form a regular chain extending from Omdraai's Vlei to the Orange River near Hopetown. The older rocks form high ground in the angle between the Orange and Vaal Rivers, and again in the neighbourhood of Schmidt's Drift. Between the Harts and Vaal Rivers they constitute a belt broadening to the north-east and covering a wide area in Vryburg and south-western Transvaal.

Towards the south and south-east of the area the general level of the country rises, the covering of Karroo sediments and intrusive dolerite becomes thicker in that direction, and the scenery is that typical of the Karroo.

A critical examination of the available data shows that the extremely slight southerly inclination of the Karroo beds over the greater portion of the area in question is most probably an original feature due to conditions of deposition. In the extreme south and south-east the dip of the strata becomes appreciable, the fall of the Karroo floor is rapid, and it is likely that there has been a slight sinking of the crust in this direction. Omitting this tract, however, it is clear that over almost the whole of the area in question the elevation subsequent to the deposition of the Karroo sediments was of uniform amount, and consequently that there was no warping either of the Karroo beds or, obviously, of the pre-Karroo surface underlying them.

Where denudation has been insufficient to lay bare this surface entirely, remnants of the Karroo formation still occupy the bottoms of the depressions in it, and thus the ridges and valleys of the palæozoic land mass can be determined. Where the tillite has but recently been removed the surface of older rock possesses in a remarkable degree the characteristics of a glaciated region, while in many places the rocks still retain glacial

striæ. Even where the older rocks are hidden by the entire Dwyka series there are certain cases in which the directions of the major valleys in them can still be made out.

Obviously the undulating surface thus determined is that of the continent at the close of the Dwyka glaciation. In making a restoration of the surface as it appeared prior to glacial times the effects of glacial action in modifying the topographical features have necessarily to be taken into account. That a considerable thickness of rock was removed from the continent is evident both from the vast area occupied by the southern Dwyka, from its great thickness, and, in the case of the northern Dwyka, from the high proportion of material in it, obviously of local origin. Differential erosion is indicated by the occurrence of rock basins, and the lower portion of the Kaap Valley has probably been much deepened, firstly owing to the direction of glaciation almost coinciding with that of the valley, and secondly to the fact that the strata forming its floor were softer and easier removed than the beds composing the high ground to the north-west and south-east. Apart from this there is evidence to show that, except for the rounding off of ridges and the widening of valley bottoms, the intensity of the relief of the ground could not have been altered to any appreciable extent. It seems, therefore, not too much to presume that the main pre-Glacial drainage lines are represented with but slight modification in the major valleys of the glaciated Karroo floor.

The Palæozoic Drainage.—There is no portion of the area, indeed, where the palæozoic drainage lines can be more clearly seen than that immediately south of Vryburg, for the present river system is practically a replica of that of the past. At Brussel's siding the valley is about a mile wide and at least 300 feet deep, but at Taungs it broadens and the depth must have been over 800 feet. The main artery extended down the Kaap Valley, receiving a small tributary from the north-west at Boetsap and a larger one near Read's Drift. The channel probably continued to near Prieska, and then turned southwards in opposition to the course of the Brak River, passing between the T'Kuip hills and the ridges north of Beer Vlei; further into the Karroo its exact direction cannot be traced. The evidence regarding the area north-west of Prieska is not quite conclusive, but so far as it goes does not support the assumption that the valley of the Orange River from Prieska to Kheis is cut along a pre-Karroo valley. The drainage from the southern part of Hay and from the Doornberg Range in all likelihood entered the main valley at Prieska.

Another important branch came down from the Transvaal; it crosses the present Vaal River, first above Warrenton, again at Windsorton, receiving two tributaries from the east, and leaves it at Pniel, striking in a south-westerly direction to Douglas, where it joins the main stream in the Kaap Valley.

Another line of drainage starts a little to the east of Kimberley, extending in a south-westerly direction; in its lower reaches it almost coincides with the Orange River just above the junction of the latter with the Vaal. South-westwards from Belmont past Hopetown and down to

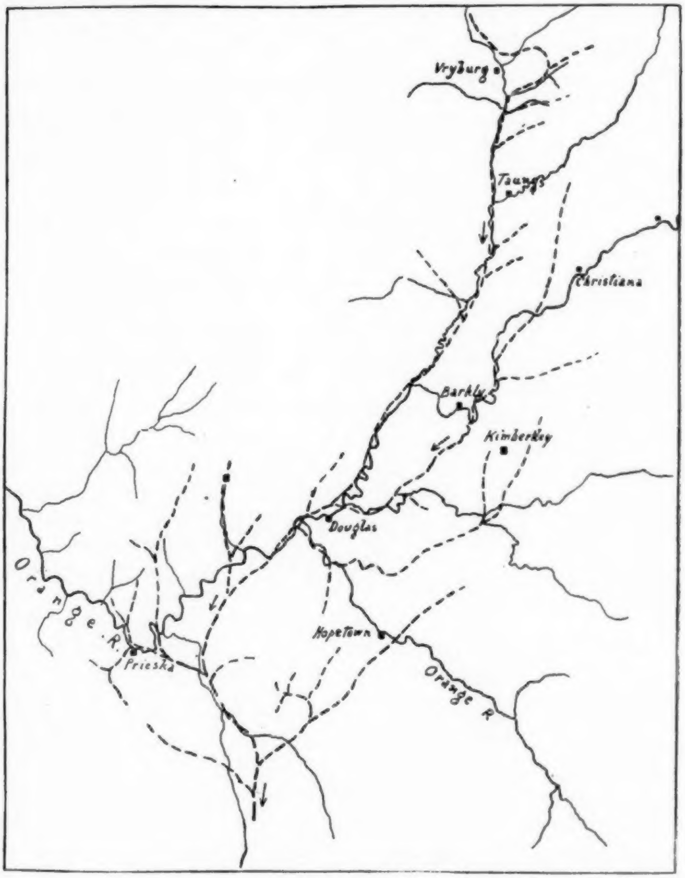


Fig. 1.

Beer Vlei an important feeder can be traced, traversing an area of little relief, but nevertheless possessing a rather intricate drainage system.

West of the Doornberg some of the rainfall certainly flowed in a southerly direction.

The palæozoic valleys are intimately connected with the strike of the underlying formations, hence the majority of the river-courses strike south-westwards; wherever the direction of the folding changes that of rivers is correspondingly altered, as, for example, around and to the west of the Doornberg where the strike of the rocks is now south-eastwards. Transverse valleys also occur, but are not so conspicuous or so important. The direction of the principal palæozoic drainage lines is indicated in Fig. 1.

The sediments derived from the denudation of this palæozoic land surface must have been carried southwards and deposited in that direction. Since this process of denudation was terminated by the Dwyka glaciation, and since in the south of the Karroo there is a perfectly conformable succession from the Cape into the Karroo system, the inference is obvious that this land surface was a source, and an important one too, of the sediments that formed the Cape system of rocks.

It is not necessary to go into details regarding the physiography of the area during late Palæozoic times; this has been fully discussed elsewhere.* Sufficient is it for our purpose to state that the surface was intensely glaciated, and then buried beneath the Karroo sediments during the Permian and Triassic epochs.

Whether the Stormberg series was ever deposited over central and northern Cape Colony is a matter of conjecture; the evidence so far is very slender, but if the view is correct that this series is represented in central and northern Transvaal, in Rhodesia, and in the Bechuanaland Protectorate, then the formation was in all likelihood laid down in this portion of Cape Colony as well. At the close of Stormberg times the Karroo strata were injected by innumerable sheets and dykes of dolerite over an enormous area.

The post-Karroo Denudation.

From the commencement of the Permian down to the Jurassic epoch at least the old drainage system lay dormant, so to speak, beneath a great pile of strata. Upon the surface of this "plain of deposition" the present drainage system of South Africa was initiated. According to Professor Schwarz † the determining factor in the stream directions was a "main watershed" extending from Cape Town to Delagoa Bay. This view has, however, been adversely criticised by Professor Davis,‡ while the author § has shown that in the Drakensberg area the drainage is

* Rogers and Du Toit, "Geology of Cape Colony," chap. xiii., 1909.

† E. H. L. Schwarz, *Geographical Journal*, xxvii., 1906, p. 265.

‡ W. B. Davis, *Bull. Geol. Soc. of America*, vol. 17, p. 387, 1906.

§ A. L. Du Toit, *Trans. S.A. Phil. Soc.*, xvi., pt. 1, p. 53, 1905.

intimately connected with the gentle warping of the strata in that region. It is most suggestive to find that the two principal directions of the rivers are north-west and south-west, and that to the latter belong the head of the Orange River, the Kraai River, and Caledon River, all flowing in gentle synclines, though the explanation of the course of the Vaal is not quite clear.

Whatever may have been the character of the Karroo drainage when initiated, it is not unlikely that it had been considerably modified even at the early period at which it can be recognised in the area under discussion. It has been pointed out that as a result of denudation an extensive peneplain was produced at the 6,000-foot level in the Stormberg area at a period when the continent stood at a much lower level than now; from this peneplain there rose to a height of from 2,000 to 5,000 feet—possibly higher—such portions of the volcanic masses of the Drakensberg and Basutoland as had escaped erosion by the head-waters of the Orange River. A peculiarity of the present main watershed right through the Karroo is that the northerly flowing streams take their rise at the edge of an escarpment which faces the south; owing to the cutting back of the latter there can be no doubt that the crest has gradually been shifted northwards and that the divide formerly lay very much further to the south of its present position.

Following this period of planation which was caused either by the cessation of the upward movement of the Continent, or possibly by a slight subsidence, there came a renewal of the uplift of such an amount that the river meanders were incised to a depth of over 1,000 feet between the Drakensberg and Aliwal North, and ultimately the present surface was formed at an altitude of between 4,000 and 4,500 feet over the area north and north-west of the Stormberg.

It is of great significance to find that in the area under consideration the oldest recognisable peneplain is that whose lowest altitude stands now somewhere about 4,000 feet above sea-level and into which the Orange River near Prieska has cut its channel to a depth of about 1,000 feet.

This remarkable physiographic parallelism in two areas, 250 miles apart, namely, a period of extensive planation followed by incision of the valleys to a similar amount in each case, subsequent to which there has been comparatively little variation in the character of the erosion, is very suggestive. The probability is therefore considerable that the same forces operated over the whole of the area in question and that the planation in Griqualand West was synchronous with that in the Stormberg.

A large portion of the Griqualand West peneplain remains hardly modified in the Kaap Plateau, with its gradual and uniform rise of from 15 to about 25 feet per mile from its edge (4,000 feet) towards the north-west. It is cut in crystalline limestones and dolomites, and the few

gentle features which vary its monotonous aspect are caused by beds of resistant chert. The post-Karroo origin of the plateau is proved by the fact that both at Boetsap and near Mark's Drift the Dwyka shales have been cut to a flat equally with the Campbell Rand limestones.

Gravels are still found *in situ* on this surface, namely, between Kuruman and Vryburg, at an altitude of 4,750 feet, the pebbles having obviously been transported some distance, and along the edge of the Kaap at 4,000 feet, near its south-eastern extremity, where water-worn pebbles of the jaspers of the Griqua Town Hills predominate.

The occurrence of these durable brown jasper pebbles is of immense value in determining the existence of former deposits of gravels, for the rocks from which they were derived are only known in the Griqua Town and Doornberg Hills, and inclusions of this material are not found in the Dwyka tillite in the area under consideration.

These jasper gravels are found *south* of the Orange River as far away even as Hopetown—a distance of 70 miles from their nearest possible source, and at an altitude of 3,600 feet. Small fragments are not uncommon over Hopetown and Britstown up to altitudes of nearly 4,000 feet, and, though some can be accounted for as having been carried by the aborigines for the purpose of making implements, they are so numerous that there can hardly be any doubt that they are the relics of gravels deposited by streams arising in the north and north-west, for it is noteworthy that the pebbles become gradually smaller in size to the south-east.

Further south in Carnarvon, Victoria West, Richmond, and Philipstown lies a belt of rugged country, composed of terraced dolerite-capped hills, in which isolated peaks attain an altitude of over 5,000 feet, and in some instances of over 6,000, and which is situated some distance to the north of the main watershed of the Colony. In this important mountainous region, owing to subsequent erosion, no traces of the peneplain remain.

The course of the rivers over the original surface of this peneplain, which can be named the Kaap Peneplain, is naturally impossible to determine with any pretensions to accuracy. In the north the emergence through the cover of Karroo rocks of the crests of the once-buried ridges must have determined the water partings in that quarter. In the north, therefore, the old drainage was re-established, but in the south, where the ancient rocks were still deeply buried, new drainage lines were set up and attained some measure of permanency. The evidence obtainable seems to show that the position of the Orange River lay many miles to the south of its present course in Hopetown. Below Prieska its direction may have followed more or less that of its present course, and it is noteworthy that the evidence for the existence of the peneplain in this quarter is found in the remarkably flat-topped ridges of the Doornbergen, the Kheis Hills, Ezel Rand, and Langebergen in contrast to their jagged

foothills and despite the facts that the hard strata forming them are highly tilted and disturbed.

From the positions of its gravel terraces the Vaal River seems to have occupied a course probably not very far removed from its present one, but from the occurrence of fragments of crocidolite and jasper in the gravels near Klipdam—it is most likely that the Harts River was not then in existence. If we therefore reconstruct in imagination this surface we find it extending away from the foot of the basalt terraces of Basutoland, north-westwards to beyond Prieska, and northwards over the Orange River Colony and the south-western corner of the Transvaal.

Between Aliwal North and Prieska the fall of the surface will have been from the 6,000 to the 4,000-foot contour, or at the rate of 9 or 10 feet per mile—just about twice the gradient of the Orange River in this section. Should this value be thought too much, it may be stated that in post-Karroo times the southern and south-eastern portions of the Colony appear to have been in a more unstable condition than the interior, and that there may have been a tilting of the surface of planation due to a greater uplift in the Drakensberg region. A comparison with the Kaap Plateau, however, brings out the fact, that in the latter the gradient possesses a somewhat greater value.

In attempting to determine the geological date of this uplift, it seems most likely that the movement was closely connected with that by which the outliers of Uitenhage (Lower Cretaceous) beds were faulted down in the folded belt of the south of the Colony, for in every case the upthrow is on the north or inland side. Again in late Cretaceous times there was a gental crustal flexuring which affected the belt of high ground (Drakensbergen) running almost parallel to the Indian Ocean—a feature which has been ably discussed by Professer Penck.*

On this assumption the cutting of the Kaap-Stormberg peneplain can be ascribed to the close of the Cretaceous epoch while the entrenchment of the river valleys and the development of the present surface features may have been produced entirely within Tertiary and post-Tertiary times. In this connection, therefore, it may be noted that in comparing the amount of the denudation in the Karroo with that in Arizona Professor Davis † has pointed out that in the former the amount of erosion appears to be less than would be expected if it had taken place during much of Cretaceous as well as the whole of Tertiary times.

* A. Penck, "Sitz. Kgl. Preuss. Akad. d. Wissen.," p. 230, 1908.

† W. M. Davis, *Bull. Amer. Geol. Soc.*, vol. 17, p. 444, 1906.

Dissection of the Kaap Peneplain.

Through a renewal of river activity brought about by this elevation of the continent, aided by such tilting as may have occurred, the peneplain was gradually dissected into its present condition. That the erosion was everywhere uniform in degree is shown by the relics of gravel terraces preserved here and there at different altitudes. The causes for these are, without doubt, complex, but the most important factors certainly are—intermittent elevation, climatic variation, and the existence of rock barriers athwart the stream-courses.

The evidence derived from the coastal area, as shown by shelves or ledges at different altitudes,* points to spasmodic elevation, but in the interior, which was presumably an area of lesser instability, this process was very possibly more uniform. The succession of gravel terraces is not necessarily a proof of intermittent elevation, for in a number of cases these shelves can in the clearest manner be seen to have been caused by the action of rock barriers, as these were one after the other exposed by the rivers in sawing down through the cover of Karroo deposits. The possibility of climatic variation will be considered later on.

The elevation of the continent was no doubt due to isostatic adjustment following the denudation of its surface.

The Orange River from the Basutoland border down to Hopetown, flows at a depth of from 100 to 200 feet below the surface of the adjoining country. Wherever a dolerite dyke or sill crosses the river its channel becomes narrow and the gradient steeper; above such a point there is usually a smooth reach for several miles. A good example of such a barrier is just above the railway bridge at Hopetown. Below this point there begins a peneplain at an average altitude of 3,600 feet above sea-level, and traceable over a considerable area in the Hopetown Division. Its origin may possibly be connected with the cutting of the channel of the Orange through the hard rocks below Prieska. At Hopetown itself this terrace is from 140 to 200 feet above the level of the present river, and the gravels contain abundant pebbles of amygdaloidal basalt from the Drakensberg, such pebbles being absent from the high-level deposits of the Harts and Vaal Rivers. Below Hopetown the Orange River leaves the Karroo formation and plunges into a deep gorge cut in diabase and quartzite, and its rapid fall only terminates when it enters once more an area of Dwyka tillite and shale. From this point down to its confluence with the Vaal it courses along the base of a ridge of diabase rising in places to a height of 800 feet above it. At Read's Drift it has sawn a narrow channel, with precipitous sides in a peneplain cut in the Campbell

* E. H. L. Schwarz, *Q. J. G. S.*, p. 70, 1906; *Amer. Journ. Science*, Sept., 1907, xxiv., p. 185.

Rand limestones; below the point down to Prieska its winding channel is hemmed in by banks of Dwyka tillite. All along the course of the river, and sometimes nearly 15 miles away to the south are terraces capped with gravels cemented with carbonate of lime, and usually prominent features in the landscape. For this reason the gravels, which appear to be diamondiferous, are unworkable. At Prieska the altitude of the river-bed is only 3,020 feet, so that the Kaap peneplain has been dissected to a depth of about 1,000 feet. The Riet River is in many respects a duplicate of the Orange. Along with its tributary, the Modder, it drains a wide area of but little relief in the Orange River Colony, enters a deep and narrow gorge cut in diabase below Modder River Station, and for some distance before joining the Vaal River has its channel incised in a terrace cut equally and uniformly in both shale and dolerite.

A most interesting feature about the Vaal River is that in a distance of 100 miles above Christiana the fall is only 30 feet, or less than 4 inches per mile, whereas from Warrenton to Barkly West the fall in 60 miles is just over 300 feet.

In sawing downwards the Vaal River has come across several of the buried ridges of the pre-Karroo diabase, and in them it has in time cut deep and steep-sided gorges. The two most important barriers are the one between Warrenton and Windsorton and that between Barkly West and Longlands. Above such a barrier downward erosion has been checked, while below it the Dwyka tillite has been rapidly removed; hence at the lower end of each gorge are several gravel terraces occasionally with slopes connecting those at different levels, whereas above the barrier there is usually a single terrace the period of the formation of which is equal to the sum of those below the gorge. For this reason it is very difficult to correlate according to age terraces along different sections of the river.

Along this portion of its course the Vaal River forms a most interesting study, and shows in a clear manner the mutual dependence of different sections, the results of interference caused by minor obstructions, and the delicate readjustments of the rate and extent of the erosion in both a vertical and lateral direction. The peculiar hummocky surface of the diabase, with its Dwyka-filled, steep-sided, and ramifying depressions has obviously exercised an important influence in shifting the course of the river and its lateral streams from time to time.

Gravels, usually diamondiferous, are found along the Vaal River at altitudes up to 400 feet above its present bed preserved on slopes or shelves cut in amygdaloidal diabase, sometimes miles away from the river.

Whereas the Vaal River was hampered by hard diabase, in which it

ultimately has succeeded in cutting its channel to a depth in places of 400 feet, a small tributary which may possibly have joined it near Klipdam was only faced with shales and dolerite. It was therefore able to cut its way backwards, at the same time shifting its course laterally towards the north-west and finally forming the Harts Valley.

This river, although possessing only a fraction of the flow of the Vaal River, has been able to re-excavate a section of the pre-Karroo Kaap Valley, capturing during its progress the drainage which the Vaal would have received from the north and north-west. The removal of material, principally shale, has been so extensive that the Harts River in the lower part of its course now meanders in a broad valley, whereas the Vaal is devoid of loops with the exception of the curve known as the "Bend," which is due to the excavation of a basin filled with Dwyka tillite and shales. The most interesting feature concerning the Harts River, and one that is so dependent on the nature and history of the palæozoic land surface is the fact that over a great distance its channel possesses a far lower gradient than that of the Vaal River.

That a tributary should flow at a lower level than the main stream for such a distance is almost unique, and upon this peculiarity a great irrigation scheme has been based.* It has been proposed, in fact, to divert a portion of the flow of the Vaal River just above Warrenton and lead it up the Harts Valley as far at least as Taungs. As a matter of fact, the altitude of the Vaal River is 3,880 feet above sea-level, while that of Taungs Station is 3,590, and Brussel's siding only 3,700—that is, the water could be taken to within a few miles of Vryburg, 70 miles away to the north.

The Kaap retains its peneplainic features to a marvellous degree; this is apparently due to two causes. Firstly, the Dwyka tillite and shale which was banked up against the limestone escarpment has protected the face from active erosion up to a very late stage. Secondly, owing to the jointed nature of the limestone the rainfall is conducted underground, as is proved by the numerous springs along the base of the escarpment. The surface has also been protected to a certain extent by a deposit of calcareous tufa. South of Griqua Town, however, the Sand River has been very active in removing the Dwyka where the peneplain is continued over this formation.

Lastly, we come to the consideration of the Brak River and its various tributaries which drain the area north of the main watershed in De Aar, Richmond, Victoria West, and Britstown. Over the greater part of this tract of typical "Karroo" country the rivers flow along channels but slightly incised in the broad flat plains, but here and there they have cut narrow gorges through dolerite ridges and occasionally through miniature

* Report of the Director of Irrigation, &c., Parliamentary paper G 41, 1906, p. 57.

sandstone plateaux. Below T'Kuip the Brak River flows in a moderately broad depression excavated in tillite to a depth of 200 feet below the general surface; along this section it receives no important lateral streams, the area both to east and west being characterised by the depressions known as "pans." In the Brak River catchment area gravel terraces occur at various altitudes and sometimes at a distance from the present channels; the boulders consist principally of dolerite, and lydianite and quartzite produced by the contact action of the intrusions upon the Karroo shales and sandstones.

Origin of the Veld.

Under this title Professor Davis * has discussed a number of possible theories as to the development of the present surface features of central South Africa. Passarge † has pointed out how a peneplain might gradually be formed in an arid region and how it might subsequently be dissected either by warping or else by a change to a more humid climate; he has suggested that this might be the case with the Kalahari, and that the latter, and consequently the Karroo as well, might have been dissected at their present level.

Against this view we have the improbability that the Karroo was elevated continuously several thousands of feet, for the nature and position of the cretaceous rocks and the recent marine terraces in the coastal region show that this elevation proceeded by steps and that the upward movement has continued down to within recent times. Peneplains are, moreover, normally developed at low levels with respect to the surface of the ocean. With regard to the question of climatic variation, Passarge ‡ has elaborated a cycle of changes from humid to arid and back to humid conditions in Tertiary and Pleistocene times. It is not yet known, however, to what extent the phenomenon of the silicification of sands and limestones can be relied upon as indication of a former arid climate.

The evidence in Bechuanaland,§ slight as it is, is in favour of some variation in climate, and it seems not unlikely that during a certain stage in the elevation of the continent more arid conditions prevailed over northern Cape Colony at least.

It cannot be denied that, as stated by Davis, the Karroo exhibits a decidedly mature type of erosion; this can be well seen in Hopetown and

* W. Davis, *l.c.*, p. 435.

† Passarge, "Zeitschr. d. Deutsch. Geol. Gesellsch.," lvi., 1904, protokol, p. 193; "Naturw. Wochenschr.," new series, vol. iii., 1904, p. 657.

‡ Passarge, "Die Kalahari," Berlin, 1904.

§ *Ann. Rept. Geol. Commn.* for 1907, pp. 155–7.

Britstown for example. Although this is the case over a large area, I think that the proportion of country possessing stronger relief has been much underestimated. For example, we have the Karreebergen and the block of rugged ground joining the Nieuwveld to the Sneeuwbergen and Stormbergen. The Dwyka and Ecca shales crumble away rapidly and form flats dotted with little dolerite ridges and pinnacles, while the Beaufort sandstones are far more resistant. Again, the inclined sheets or sills of dolerite form far more serious obstacles to denudation than the nearly horizontal intrusions; the latter, when they occur on the flats, are not uncommonly decomposed to a friable material. The time required for the dissection of the peneplain into such an area of low or moderate relief may therefore have been comparatively small; thus the argument that with a late uplift of the continent the stream-courses would be incised and the rivers would have been unable to cut out a peneplain is very much weakened. As a matter of fact, however, it is just the incised nature of the channels of the Orange and Vaal Rivers which has prevented the development of irrigation schemes along their courses, while it has already been pointed out that the Orange River flows in a gorge throughout this area, the same being true of its channel below Prieska and below Upington. With a late uplift, however, there may have been rejuvenation of the lower reaches of the Orange, while the upper portion of the drainage system may have been but little affected by the elevation.

The view that the "Veld" is due to erosion under arid conditions within recent times is not borne out by facts. Firstly, gravel terraces occur at various altitudes as already described; secondly, the existence of dry river-channels, such as the Molopo in Bechuanaland, indicate that the rainfall is probably less at present. At the present day the rivers are quite able to dispose of the products of disintegration, for the flats are covered with but a scanty soil. Belts of sand cover extensive tracts of country, but the material is principally wind-borne, and is due to invasion from the north-west; practically, however, the whole of the sand is fixed by grass.

The existence of numerous pans inland affords no decisive evidence of climatic changes. There is no doubt that they have been formed principally through the agency of the prevailing northerly or north-westerly winds,* but while some pans are being filled up with sand at the present day others are undoubtedly being deepened. Their positions are usually independent of any drainage system.

From the writings of the older travellers, which are confirmed by the accounts of the oldest residents in the Colony, there is no doubt that the human habitation of the Colony has been a most important factor, and one that has not been sufficiently reckoned with in modifying the face of the

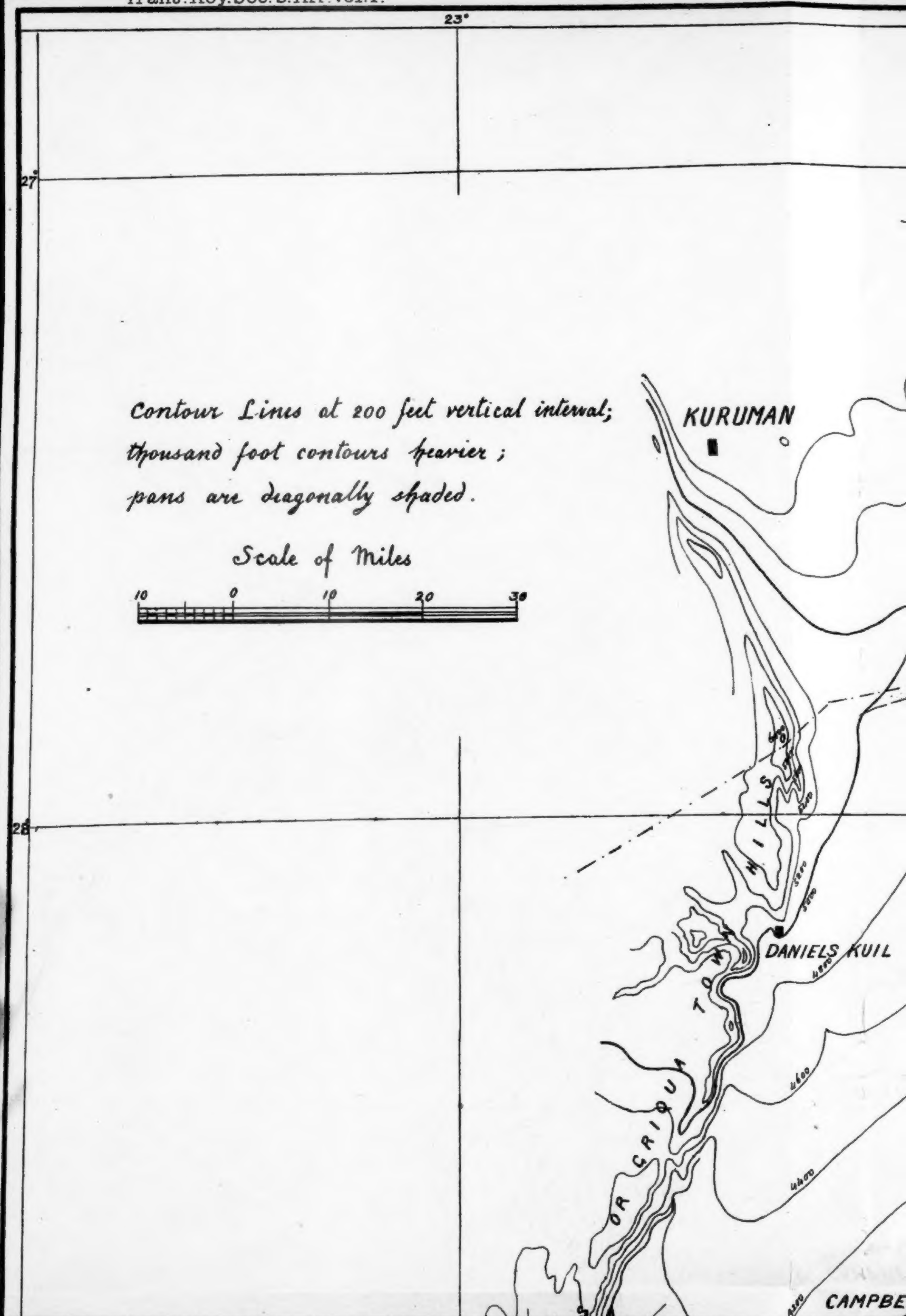
* *Ann. Rept. Geol. Commn.* for 1906, p. 131.

country, unfortunately not for the better; the overstocking of the farms and their deforestation are reducing the Karroo to a barren tract.

Summary.

In Palæozoic times a continent extended over the area in question, and the drainage from it was directed southwards, the Kaap Valley forming the principal channel. At the close of the Carboniferous epoch this continent, which stood at a lower level than it does now, was ntensely glaciated and finally buried beneath the Permo-Triassic Karroo deposits; upon the surface so formed the modern drainage was initiated.

The denudation of the newly formed continent has been greatly aided by the elevation which has in time brought it to its present altitude; but this uplift has been spasmodic, and appears to have acted during several distinct periods in late Jurassic and in Cretaceous and Tertiary times. With each cessation of movement the rivers have been enabled to cut a peneplain, and one of the most mportant of these surfaces extended from the Stormberg probably into Griqualand West, where it is represented by the Kaap Plateau. Since late Cretaceous or early Tertiary times this surface has experienced denudation; the rivers have cut down and laid bare in this area the pre-Karroo floor with its drainage lines, and the development of the modern river system has been greatly influenced by reason of its superposition upon that of Palæozoic times. The Karroo owes its peculiar type of scenery in part to its geological structure, in part to the prolonged nature of the erosion to which it has been subjected, and in part to the climatic conditions which existed during its development.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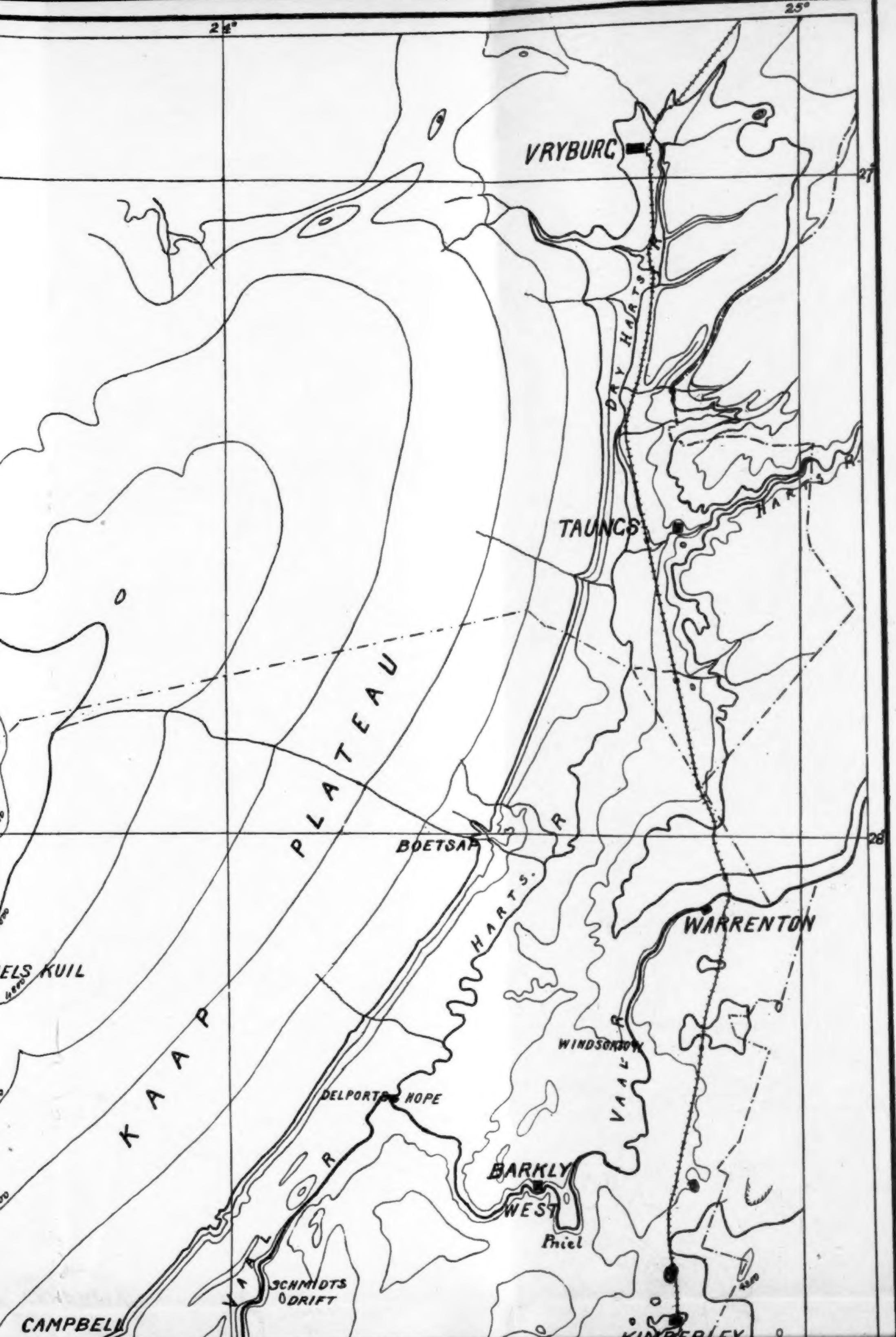
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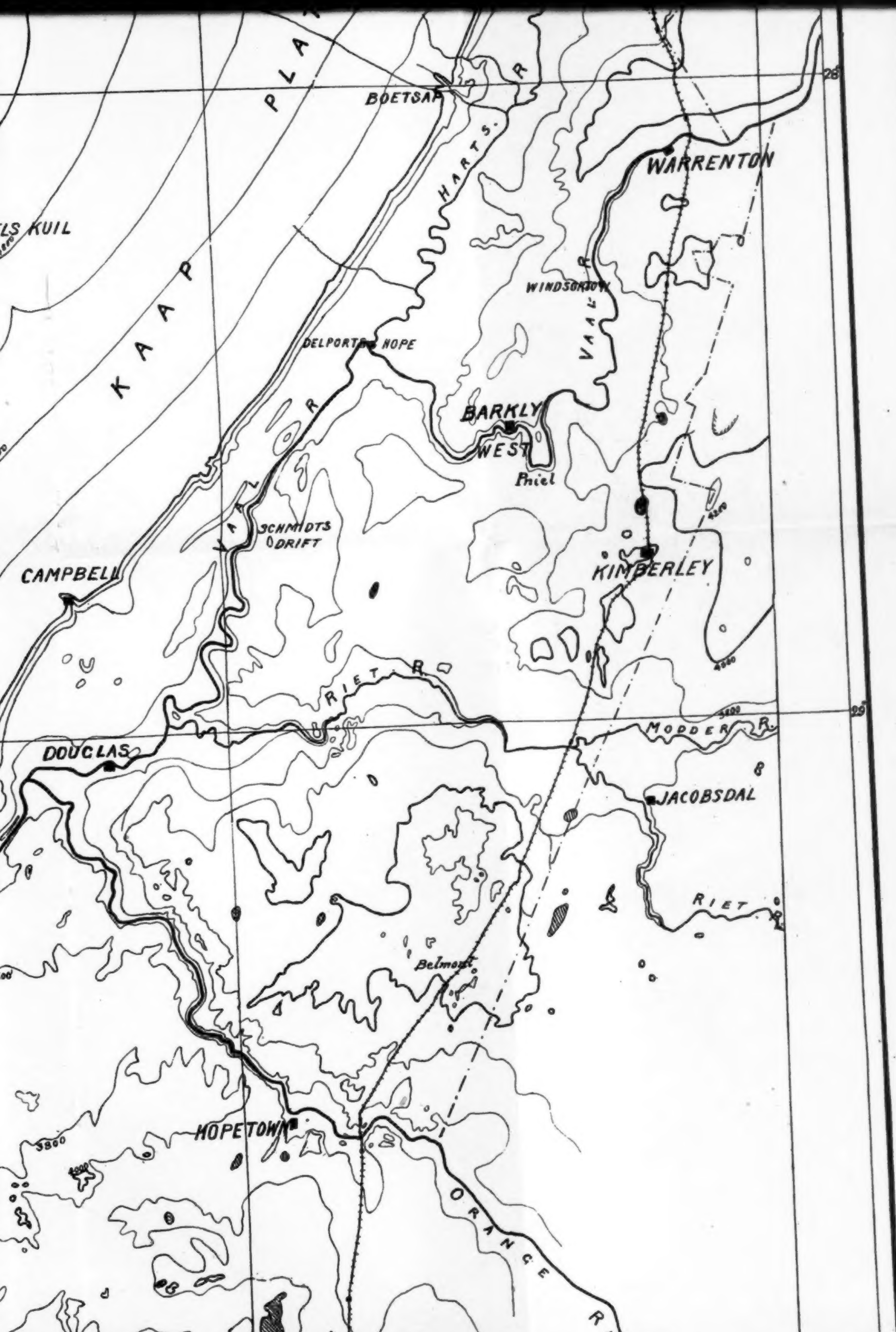
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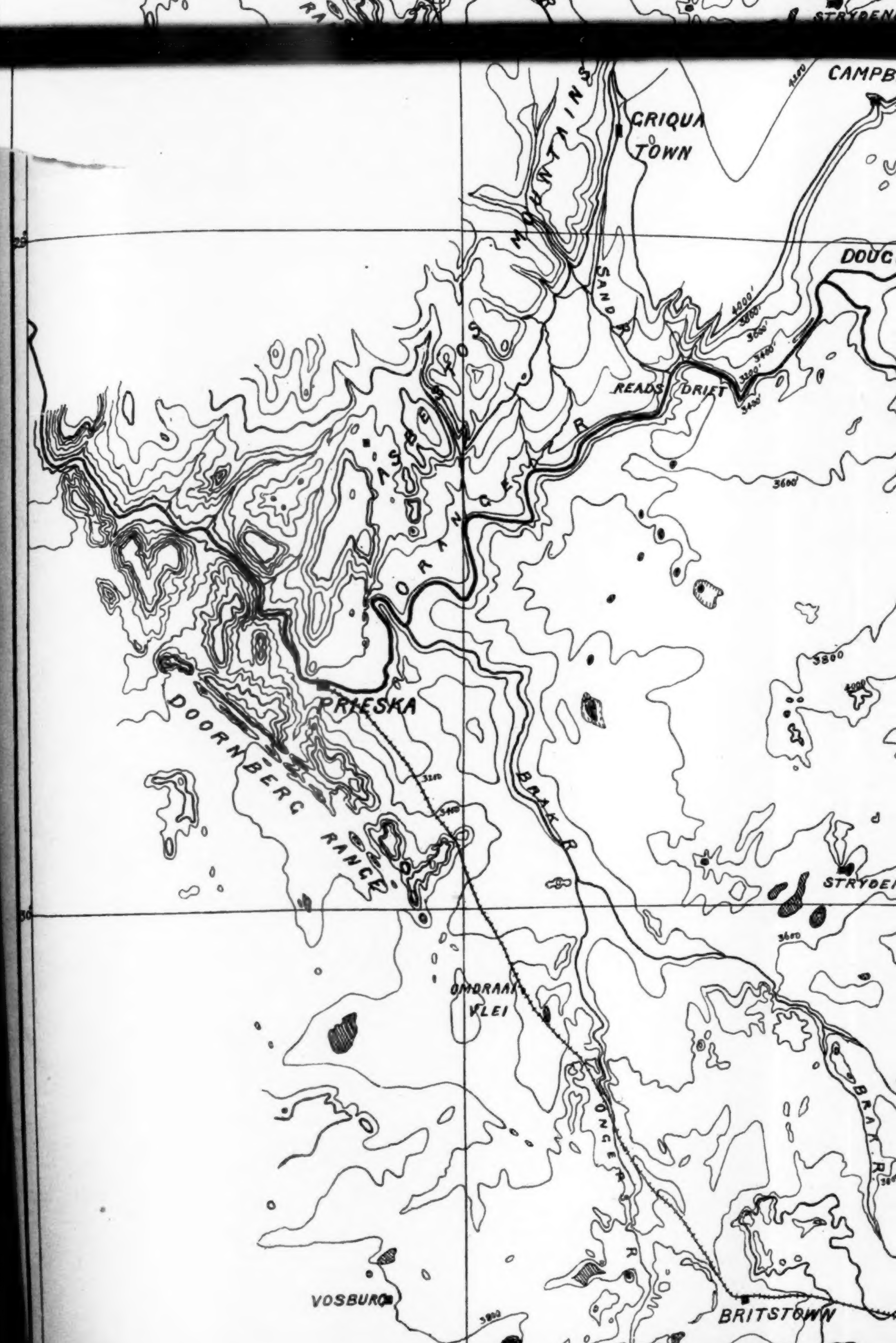

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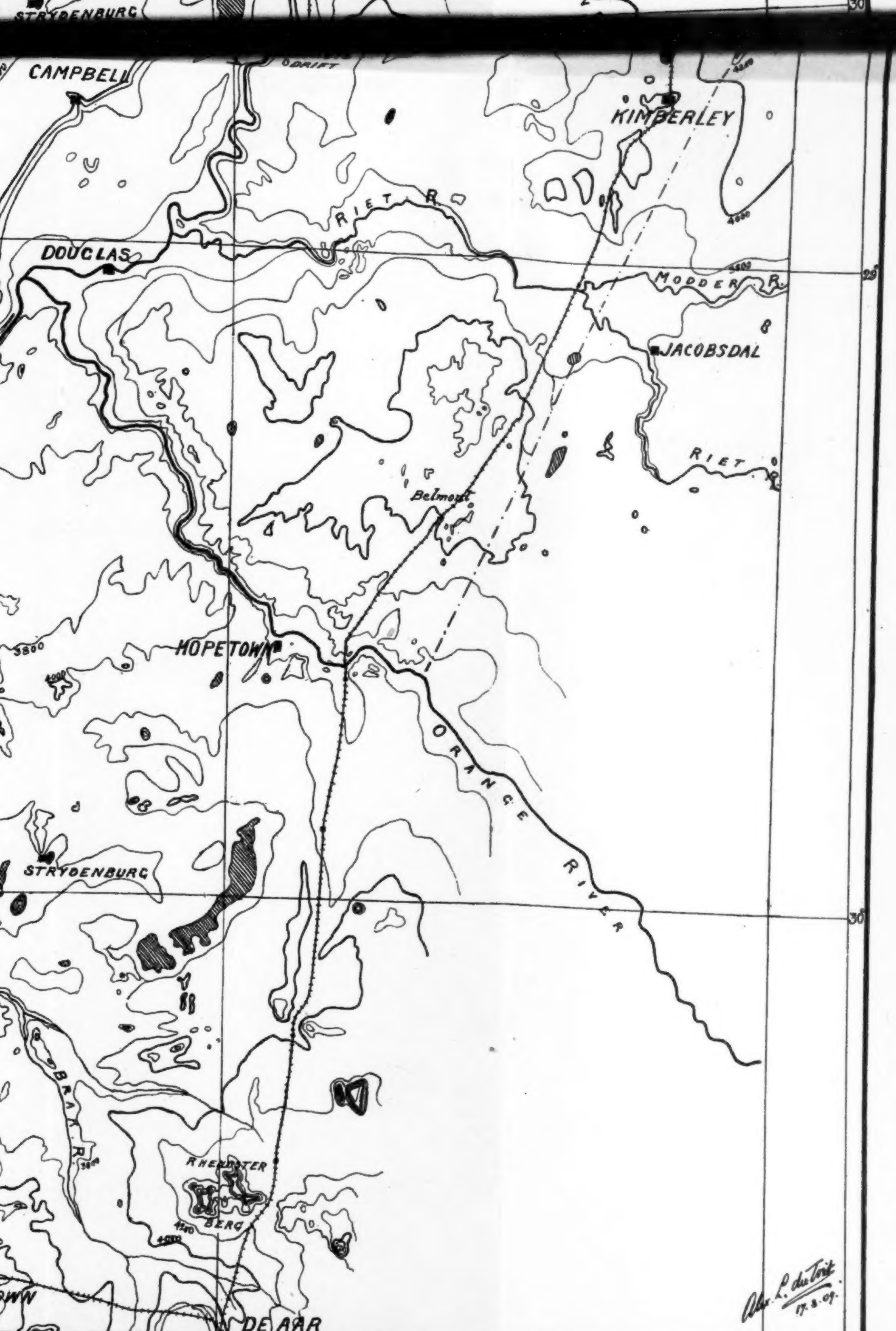


West, Newman photo-lith

THE RAINFALL OF SOUTH AFRICA. THE POSSIBILITY OF PREDICTION OVER THE SOUTH-WEST.

By A. G. Howard, M.S.A.

(Communicated by L. Péringuey.)

(Read May 19, 1909.)

If we take Clanwilliam, the Royal Observatory, and L'Agulhas, we have a triangle covering the south-west of Cape Colony, and as weather over that portion of South Africa forms a prelude to that all along the coast, it is evident that if we can ascertain beforehand what is in store within this triangle, we have the key to forecasting for the whole of the Colony. The position of L'Agulhas is one of great importance, and the movements of the barometer there in relation to those at the other two stations will indicate to a great extent what further atmospheric movements are impending.

By the kind courtesy of the Acting Secretary to the Meteorological Commission, during the absence of the Secretary in England, I have had access to the records of the morning simultaneous readings for several years, and have arranged them in groups, wherein each triad of readings bear a relationship to each other.

As I consider Cape L'Agulhas of such importance, I have taken into consideration the wind there, without reference to that at the other two stations; in fact, the wind records at these two stations are not of much value, especially when taken at 8.30 a.m.

In registering the rainfall I have given that recorded at the Royal Observatory, but inasmuch as the indications refer to a wide field, it may be that in some instances rain fell away from that station, and although the forecast would appear to be a failure, still, had records from all places in and around the triangle been taken, we might have seen a verification of the forecast.

In an investigation of this kind the first question to be asked is: "What amount of rainfall should be considered as constituting wet weather?" I should say that anything beyond 0·05 of an inch would

meet the case. But if we are dealing with conditions indicating wet weather we are justified in taking any fall at all—even 0·01 in.—as showing a verification of the forecast. If, however, we are dealing with conditions indicating dry weather, we shall be quite in order if we take all falls between 0·01 in. and 0·05 in. as of no importance. The atmospheric conditions governing rainfall are so very erratic that we will be justified in this course of action; for instance, suppose the indications are for rain and only 0·01 in. falls, the slightest change in the atmosphere, all indications of which are present, will give a greater fall—it is a mere accident that the fall is so slight; but if the indications are for dry weather and a fall of 0·05 in. follows, this also is accidental, and any atmospheric difference will make for less fall or none at all. In some cases when no rainfall is recorded at the Royal Observatory, it is seen to have fallen at L'Agulhas; this might be considered if the conditions are for rain, as it is not due to accidental circumstances; but if the reverse be the case and still rain falls at L'Agulhas, then it may be due to causes further afield than those indicated by the triad of readings, and is thus outside our investigation.

Taking, now, the barometric readings at the three stations, let us see how we can reduce them to a tabulated form. In the first place, we will divide them into primary groups: (I.) Where the general pressure is decreasing; and (II.) Where it is increasing. In some cases a single station's barometer may have a reverse movement to the other two, but this will not upset our argument.

In each of these two groups we can arrange for the following sub-groups:—

(A) L'Agulhas most, Clanwilliam least.
(B) L'Agulhas most, Royal Observatory least.
(C) L'Agulhas most, other two equal.
(D) Royal Observatory most, Clanwilliam least.
(E) Royal Observatory most, L'Agulhas least.
(F) Royal Observatory most, other two equal.
(G) Clanwilliam most, L'Agulhas least.
(H) Clanwilliam most, Royal Observatory least.
(I) Clanwilliam most, other two equal.
(J) Clanwilliam and Royal Observatory equally most.
(K) Clanwilliam and L'Agulhas equally most.
(L) Royal Observatory and L'Agulhas equally most.
(M) All three moving simultaneously and equally.

In one or two cases the whole of the readings remained steady for 24 hours, but these I have not taken into consideration. It must be borne

in mind that in my tables I take the changes which have occurred in the pressure during 24 hours.

Each morning, when the readings are plotted down on a chart, one of them will be actually lower or higher than the others, contingent on the group we have under consideration, and this condition is of importance in dealing with the question of prediction. We can thus divide each of our sub-groups into three divisions, namely :—

(1) Where the L'Agulhas barometer has the actual lowest or highest reading.
(2) Where that at the Royal Observatory is the lowest or highest.
(3) Where such is the case at Clanwilliam.

In my investigations I have taken the relative importance of the three stations, as far as actual pressure is concerned, in the following order: First, L'Agulhas; second, Clanwilliam; third, the Royal Observatory, and where two of these are equally lower or higher, as the case may be, I have given the benefit to the most important station of the two.

Under Group I., with a falling barometer, the station having the actual lowest reading must be taken, but under Group II., with a rising barometer, the reverse will be the case.

Again, the height of the barometer at the lowest or highest station, as the case may be, has a bearing on the prediction, and must be borne in mind. Here I have separated each division thus into sections :—

(a) Readings below 29·95 in. as low.
(b) Readings between 29·95 in. and 30·05 in. as mean.
(c) Readings above 30·05 in. as high.

Finally, the direction of the wind at L'Agulhas is a factor which must receive consideration, and one's common sense will have to be exercised to decide whether an existing direction of wind is likely to change or not. This I have been unable to go into, as it is a matter of purely local observation and knowledge gained by experience, but I trust that some one else will take it up.

In the foregoing manner I have tabulated all the triads of readings—which were perfect—for the years 1902, 1904, 1905, 1906, and 1907. The reason for omitting 1903 was that the readings from Clanwilliam were not taken for four months, and I did not desire to include an imperfect year.

GROUP I.—GENERAL PRESSURE DECREASING.

SUB-GROUP (A).

If the triangle be examined it will at once be recognised that a condition like this means that a depression is advancing from the south-west, a typical winter one, and that if no other influence is at work the usual sequence of weather for such a depression will follow, and if the glass goes down low enough rain will come for certain. The influences which may upset the sequence are those brought about by a depression passing to the north of the triangle at the same time as the one from the south-west is affecting us. This can be seen by an examination of the actual differences of the barometrical pressure at the time; thus, if the reading at L'Agulhas be the lowest of the three, there is no doubt about it being a winter type depression, uninfluenced in any way; if, however, the reading at Clanwilliam be lowest, it is evident that there is a counter depression to the north which may drive away the rain and upset the prediction. Again, suppose the reading at the Royal Observatory be the lowest, then it is evident that there is either a summer type depression or a secondary to the north-west, and rain may not fall.

DIVISION (1).

Section (a).—During the 5 years, rain followed within 24 hours at the Royal Observatory on 79 occasions out of 110, while it did not on 31 days; on 61 days out of the 79 the wind was in the west, while out of the 31 days it was westerly on 16 occasions. Again, with wind in the east rain followed on 13 days and dry weather on 12. We are, therefore, justified in considering this as a rain-bringing condition. Out of the 31 cases only 3 were absolute failures as against the prediction for rain. In 16 cases rain fell, either at L'Agulhas or was delayed at the Royal Observatory or L'Agulhas until the following day. In 12 cases there would have been an element of doubt in issuing predictions, the conditions being such that we could only have stated that there was a probability of rain. In several of the successful 79 predictions a similar element of doubt existed, and we should have been justified in expressing such doubt and only predicting probable rainfall; in most of the cases no doubt existed.

Reducing the foregoing to percentages we get—110 days, total number.

95 days, rain followed; being 86 per cent.

15 days, no rain followed; being 14 per cent.

Prediction.—Wind westerly; almost certain rain. Conditions of doubt—Clanwilliam lower than the Royal Observatory—or pressure uniform at all stations.

Wind easterly; doubtful if rain will follow, unless it is seen that there is every probability of a change to the west.

Wind north or south; very uncertain if rain will follow or not.

Section (b).—Out of 36 cases, 21 were followed by rain at the Royal Observatory within 24 hours, and 15 not. It was blowing westerly on 15 days out of the 21, and on 9 out of the 15; the easterly element being unimportant. Out of the 15 days rain fell either at L'Agulhas on that or the next day, or else there was rainfall at the Royal Observatory within 48 hours upon 6 occasions, leaving only 9 days when no rain at all followed. We thus get—36 days, total number.

27 days, rain followed; being 75 per cent.

9 days, no rain followed; being 25 per cent.

PREDICTION.—Great probability of rain.

Section (c).—This condition existed on 23 occasions, and only on 5 of these did rain follow at the Royal Observatory within 24 hours. The wind was north-west and west on all the 5 wet days, the balance being 17 days north to east and 1 day calm.

PREDICTION.—Dry weather.

DIVISION (2).

Section (a).—Wind was easterly on all but one occasion. In 6 cases rain followed and in 6 dry weather; only on 4 days did rain in excess of 0·05 in. fall.

PREDICTION.—Dry weather, unless rain has already fallen, when, no doubt, it will continue.

Section (b).—This only happened on 5 occasions during the 5 years, so it is not an important condition; on 2 occasions rain followed and on 3 it did not; the wind was easterly each time: only upon 1 day did rain beyond 0·05 in. fall.

PREDICTION.—Dry weather.

Section (c).—During the 5 years this occurred upon 9 occasions, and in no instance did rain follow.

PREDICTION.—Dry weather.

DIVISION (3).

Section (a).—There was a total of 28 cases, of which 7 were followed by rain and 21 by dry weather; on 20 days the wind was easterly; on 4 days less than 0·05 in. of rain fell, and only on 3 days was the prediction for wet weather fulfilled by more than this amount falling.

PREDICTION.—Dry weather, or less than 0·05 in. of rainfall.

Section (b).—This condition prevailed upon 8 occasions, and on 6 of them no rain followed; in all cases the wind was easterly; on both the remaining days the falls were below 0·05 in.

PREDICTION.—Dry weather.

Section (c).—This happened upon 8 occasions, and on none of them did rain follow; wind was easterly on each of them.

PREDICTION.—Dry weather.

SUB-GROUP (B).

Two reasons can be assigned for this condition; either a depression is coming up from the south or a local secondary is deepening over the land. In each case an area of high pressure exists to the west, which is against the formation of rain clouds. At the same time a depression from the south has a tendency to bring rain, but one deepening over the land has the reverse effect. These two conditions can be separated when the actual readings of the barometers are examined, for if that at L'Agulhas be lowest there is no doubt whatever about there being a depression advancing from the south, but if the lowest reading be at Clanwilliam it is more than likely that a secondary is deepening over the land.

DIVISION (1).

Section (a).—During the 5 years under review, rain followed within 24 hours at the Royal Observatory on 13 occasions out of 19; wind was from some point of west upon 14 occasions.

PREDICTION.—Wet weather.

Section (b).—This condition occurred upon 8 occasions, rain following upon 4 of them; on all but 1 day the wind was from some point of west.

PREDICTION.—If due to a winter type depression, then rain to follow; but if it be a general deepening over the land look out for dry weather.

Section (c).—This condition existed upon 7 occasions, and on 3 of these rain followed; the rain bringing winds were westerly, but the dry weather was divided equally between west and east winds. Only on 1 occasion was the fall over 0·05 in.

PREDICTION.—Dry weather.

DIVISION (2).

Section (a), (b), and (c).—During the whole 5 years such a condition never occurred.

DIVISION (3).

Section (a).—This condition occurred on 7 occasions; wind was south to east each time, except on 2 calm days. Rain followed upon 3 occasions only, and on 2 of these it was under 0·05 in.

Section (b).—This happened upon 3 occasions, and dry weather followed each.

Section (c).—This happened upon 4 occasions, and dry weather followed each.

PREDICTION for Division.—Dry weather.

SUB-GROUP (C).

This condition can be brought about by a depression to the south or east surging back, or to a secondary deepening over the land and moving down past L'Agulhas. When L'Agulhas is actually lowest rain may or may not come, but with either of the other stations lowest it is almost certain that dry weather will follow.

DIVISION (1).

Section (a).—This condition was present upon 29 occasions; on 21 rain followed, and upon 8 it did not; on each of the 21 days when rain followed, the conditions, with few exceptions, were brought about by the advent of winter type depressions. Rain fell at L'Agulhas on 6 of the 8 occasions, so we have only 2 complete failures.

PREDICTION.—If the barometer reads lower at Clanwilliam than at the Royal Observatory, rain very doubtful. Otherwise—wet weather.

Section (b).—This happened upon 13 occasions, and on 6 of them rain followed. No particular wind can be called as prevailing for wet weather, but most of the dry weather came with west winds. The condition is one indicating rain, either at the Royal Observatory or at L'Agulhas.

PREDICTION.—Probable wet weather.

Section (c).—This happened upon 17 occasions, and only on 5 of them did rain follow at the Royal Observatory; wind was westerly for rain, and divided between easterly and westerly for dry weather; the condition is for dry weather, and only upon rare occasions is this not so; there must be a reason, but at present I cannot discover it.

PREDICTION.—Dry weather.

DIVISION (2).

Section (a).—This happened upon 2 occasions; we shall not be safe in issuing any prediction until we have more cases to guide us. This also applies to Sections (b) and (c), under each of which only 1 case occurs.

PREDICTION (Provisional).—Dry weather, but uncertain.

DIVISION (3).

Section (a).—This happened upon 12 occasions, and rain followed only upon 2; wind was generally easterly.

Section (b).—This happened upon 3 occasions, and no rain followed; wind was easterly.

Section (c).—This occurred 9 times and rain followed only upon 1.

PREDICTION for Division.—Dry weather.

SUB-GROUP (D).

This may be the prelude to a falling glass at L'Agulhas, due to a winter type depression, or it may be the result of a summer type one low down on the triangle, skirting a high pressure to the north and south. In the former case the reading at L'Agulhas will be actually lowest, and the fall at the Royal Observatory will be due to a southern depression. In the latter case the reading at the Royal Observatory will be lowest. If a summer type depression is affecting us the lowest readings will be at Clanwilliam, and this will bring down the glass at the Royal Observatory, but the influences will be for dry weather.

DIVISION (1).

Section (a).—We have 14 cases in the 5 years, and on 8 of them rain followed; on the other 6 rain should have followed. Wind was westerly in the majority of cases, both for wet and dry weather.

PREDICTION.—Wet weather.

Section (b).—This only happened upon 4 occasions, and after 3 of them rain followed. Wind was northerly.

PREDICTION.—Wet weather.

Section (c).—This only happened upon 3 occasions, and only on 1 of them did 0·02 in. of rain fall.

PREDICTION.—Dry weather.

DIVISION (2).

Section (a).—This happened upon 5 occasions, and rain followed only upon 1 of them, and then only 0·02 in. fell.

Section (b).—This happened upon 4 occasions, and after each dry weather followed.

Section (c).—This condition came upon 5 occasions, but only after 1 of them did rain follow, and then only 0·01 in. fell.

PREDICTION for Division.—Dry weather.

DIVISION (3).

Section (a).—This happened upon 10 occasions, and upon only 1 of them did rain follow, but no rain was to have been expected.

Section (b).—This happened only upon 4 occasions, without any rain following.

Section (c).—Only 3 cases, with no rain following.

PREDICTION for Division.—Dry weather.

SUB-GROUP (E).

This condition is brought about by a summer type depression, or a secondary to either a summer or a winter type one, passing L'Agulhas. Should the actual reading at L'Algulhas be the lowest, then there may be a prospect of rain. Should Clanwilliam actually be the lowest, then there is little prospect of rain, as it is a summer type depression, uninfluenced. The same applies if the Royal Observatory be the lowest.

DIVISION (1).

Section (a).—This happened upon 4 occasions, and rain followed 2 of them; wind was west for rain, but divided between west and east for dry weather. On one of the two dry days rain was expected and came at L'Agulhas.

PREDICTION.—Wet weather.

Section (b).—We have no cases of this condition.

Section (c).—Here we get only 4 cases; rain followed upon 2 with west wind, and dry weather upon 2 with north winds. In neither of the 4 cases was rain expected.

PREDICTION.—Dry weather.

DIVISION (2).

Section (a).—This only happened upon 1 occasion, and dry weather followed.

Section (b).—There were only 3 cases and 2 were followed by dry weather. All were with easterly winds.

Section (c).—This happened upon 10 occasions, and only upon 1 of them did rain follow, and then only 0·01 in. fell.

PREDICTION for Division.—Dry weather.

DIVISION (3).

Section (a).—This came about upon 17 occasions, and only upon 1 did rain follow, but no rain was expected—in fact it was abnormal.

Section (b).—This happened upon 16 occasions, and on 3 of them rain followed, but did not reach 0·05 in.

Section (c).—This happened upon 22 occasions, and rain followed only 1 of them ; no rain was expected.

PREDICTION for Division.—Dry weather.

SUB-GROUP (F).

Similar phenomena to those mentioned in Sub-Group (E) can bring about this condition, and we must be guided by studying the aspects when one or other station has the lowest reading. If L'Agulhas is the lowest it shows that the previous reading must have been higher than that at Clanwilliam, and it is evident that a depression to the south is affecting us. Then rain may follow. But under other conditions dry weather is almost certain.

DIVISION (1).

Section (a).—This happened upon 8 occasions, and on 6 of these rain followed with westerly winds, the dry winds being easterly.

PREDICTION.—Wet weather.

Section (b).—This happened upon 4 occasions, and on 3 of them rain followed. Upon the occasion when dry weather followed some rain would have been expected, and it did rain at L'Agulhas.

PREDICTION.—Wet weather.

Section (c).—This happened upon 6 occasions, and upon 4 of them rain followed, with westerly winds; but although rain followed upon these days, this condition is not one for wet weather.

PREDICTION.—Dry weather.

DIVISION (2).

Section (a).—This only happened once, and dry weather followed.

PREDICTION.—Uncertain.

Section (b).—This happened 4 times with westerly winds, and dry weather followed 3 of them. The exception was only a fall of 0·03 in.

PREDICTION.—Dry weather.

Section (c).—This occurred upon 4 occasions, and dry weather followed each; wind was from the east.

PREDICTION.—Dry weather.

DIVISION (3).

Section (a).—This occurred upon 16 occasions, and only upon 2 of them did rain follow.

Section (b).—Here we have 10 cases, and rain followed only upon 2 of them.

Section (b).—We have 6 cases, and only 1 day's rain.

PREDICTION for Division.—Dry weather.

SUB-GROUP (G).

By referring to the triangle, it will be evident that when pressure yields the most at Clanwilliam it must be due to summer type conditions. Pressure may have been so low at L'Agulhas that even with Clanwilliam falling the most the actual reading will be lowest at the former. This may lead to rain at the Royal Observatory. But under other conditions we should not expect rain. Possibly some might fall at L'Agulhas, but this would be purely coastal or Eastern Province rainfall.

DIVISION (1).

Section (a).—This happened upon 3 occasions, and on each rain followed.

PREDICTION.—Wet weather.

Section (b).—This occurred upon 4 occasions; on 2 rain followed, and on 2 it did not; rain was expected on each occasion.

PREDICTION.—Probable wet weather.

Section (c).—This happened upon 4 days, and dry weather followed all of them.

PREDICTION.—Dry weather.

DIVISION (2).

We have only 1 case, so can offer no comment.

DIVISION (3).

Section (a).—Three days followed by rain, 12 dry.

Section (b).—No days followed by rain, 15 dry.

Section (c).—Two days followed by rain, 12 dry.
PREDICTION for Division.—Dry weather.

SUB-GROUP (H).

The atmospheric movements bringing about this condition are similar to those mentioned under Sub-Group (G), and the arguments given thereunder hold good. It is purely a summer type condition, and rain is only probable when pressure is actually lowest at L'Agulhas.

DIVISION (1).

Section (a).—This happened upon 6 occasions, and rain followed 5 of them; wind was westerly on each occasion.
PREDICTION.—Wet weather.

Section (b).—Here we have but 1 case, when dry weather followed.

Section (c).—Five cases occurred under this condition; on 3 dry weather followed and on 2 rain; but on one of these days only 0·02 in. fell; wind was westerly on each occasion.
PREDICTION.—Dry weather.

DIVISION (2).

No cases at all.

DIVISION (3).

Section (a).—This happened upon 4 occasions and dry weather followed each.

Section (b).—Here we have 4 cases and dry weather followed each.

Section (c).—We have only 1 case, followed by dry weather.
PREDICTION for Division.—Dry weather.

SUB-GROUP (I).

The reasons which can be assigned for this condition are the same as in the former two groups; it is practically a condition due to the passage of smaller type cyclones or the prevalence of anticyclones. Only when L'Agulhas is actually lowest is there a probability of rain.

DIVISION (1).

Section (a).—2 cases, 1 followed by rain.

Section (b).—One case, followed by rain.

Section (c).—One case, followed by rain.
PREDICTION for Division.—Wet weather.

DIVISION (2).

No cases at all.

DIVISION (3).

Section (a).—This happened upon 5 occasions, and only on one did rain follow, but this was purely abnormal.

Section (b).—Here we have 6 cases, and dry weather followed each.

Section (c).—This happened upon 4 occasions, 2 being followed by rain, but in neither case did the fall reach 0·05 in. Wind was westerly.
PREDICTION for Division.—Dry weather.

SUB-GROUP (J).

This is an important group; it is not rain-bringing unless actual pressure is lowest at L'Agulhas. By reference to the triangle it will be seen that this is brought about by summer conditions, that is to say by a depression approaching from the north-west and passing to the north of the peninsula. When L'Agulhas is actually lowest the other two stations may have been abnormally high the day before and thus have obscured the actual condition, in which cases rain may be probable, but with Clanwilliam actually lowest rain is very improbable. Of course when a deep summer depression passes, rain may fall with a southerly wind.

DIVISION (1).

Section (a).—This happened upon 4 occasions with westerly winds, followed twice by dry weather and twice by rain.

PREDICTION.—It is a very difficult condition to predict from. We are only certain when there are signs of a depression having moved across the north to the south-east, and then dry weather can safely be predicted. Otherwise it will be better to predict rain.

Section (b).—This happened upon 7 occasions, wind being westerly; rain followed 3 times. On the remaining 4 occasions rain fell either at L'Agulhas or at the Royal Observatory within 48 hours.
PREDICTION.—Wet weather.

Section (c).—We have 7 cases, 3 followed by rain and 4 by dry weather; wind was westerly. A similar argument holds here as in Section (b).

PREDICTION.—Wet weather.

Exception; minor fluctuation in an anticyclone.

DIVISION (2).

Only one case occurs.

DIVISION (3).

Section (a).—This took place upon 24 occasions, and after 6 of them rain followed, but in no case was it expected.

Section (b).—Here we have 20 cases, and rain followed only 1 of them.

Section (c).—There were 22 cases, and only 1 day's rain.

PREDICTION for Division.—Dry weather.

SUB-GROUP (K).

This may be brought about by a decrease of pressure over the land between Clanwilliam and L'Agulhas; sometimes the barometer rises at the Royal Observatory, due to the approach of an anticyclone. It is not rain-bringing, except in special cases.

DIVISION (1).

Section (a).—This occurred 6 times, and was followed by rain upon 2 of them.

PREDICTION.—Dry weather; but if there is any indication that conditions which appear under Sub-group (A) are manifest, then there will be a great probability of rain.

Section (b).—There are no cases.

Section (c).—Here we have 5 cases, only 1 of which was followed by rain.

PREDICTION.—Dry weather.

DIVISION (2).

No cases.

DIVISION (3).

Section (a).—No cases.

Section (b).—Here we have 4 cases and no rain.

Section (c).—There are only 2 cases, 1 followed by rain and 1 by dry weather. Rainfall was only 0·06 in.

PREDICTION for Division.—Dry weather.

SUB-GROUP (L).

This is an important condition; it can be brought about by an advancing winter type depression, or by one pushing down from the north after the centre has passed Clanwilliam. It can also happen when an existing depression to the south surges back by deepening. When L'Agulhas is actually lowest and the glass is low, a winter type depression is sure to be affecting us and rain is almost certain, but when the glass is either mean or high a depression from the north is more than likely the cause of the disturbance, when rain is not likely to fall. With the barometer lowest at the Royal Observatory or Clanwilliam, summer type conditions may be prevailing and rain not probable.

DIVISION (1).

Section (a).—This condition came about upon 27 occasions, and dry weather followed only 5 of them; wind was generally from a westerly direction. Looking at these 5 cases I find that each was in connection with a winter type depression, and that rain would have been predicted. In 4 cases rain did come as an accompaniment to the depression, but not under 48 hours.

PREDICTION.—Wet weather.

Section (b).—Here we have 11 cases with westerly winds prevailing; only on 3 did rain follow, in 1 instance being only 0·02 in.

PREDICTION.—Dry weather.

Section (c).—This happened upon 14 occasions, and rain followed 4 of them; no rain would have been looked for as following any of these 4 cases.

PREDICTION.—Dry weather. At the same time the glass and sky should be carefully watched, to see if there is any indication that the yielding pressure is due to an advancing winter type depression, when slight rain is probable.

DIVISION (2).

Section (a).—2 cases; dry weather followed.

Section (*b*).—2 ,, ,, ,, ,,

Section (c).—4 ,, ,, ,, ,,

PREDICTION for Division.—Dry weather.

DIVISION (3).

Section (a).—This happened upon 14 occasions, and only upon 2 did rain follow; wind was generally easterly.

Section (b).—Here we have 8 cases, and only 1 of them followed by rain.

Section (c).—There are 4 cases, each followed by dry weather.

PREDICTION for Division.—Dry weather.

SUB-GROUP (M).

By "simultaneous" I mean a difference among all barometers not exceeding 0·02 in. Thus, if the falls be 0·06 in., 0·06 in., and 0·08 in. respectively, this would be placed here; but should the falls be 0·06 in., 0·07 in., and 0·09 in. respectively, it would be put down under Sub-Group (J).

This condition is brought about by a very widespread yielding of pressure, and may be due to many causes—the passing away of an anticyclone; the diminution, temporarily, of an anticyclone; the general deepening of a large depression, &c.

DIVISION (1).

Section (a).—This happened upon 3 occasions, rain following 1 of them, when 0·35 in. fell at the Royal Observatory, and none at L'Agulhas; however, on the 2 remaining occasions rain did come within 48 hours.

PREDICTION.—Probable wet weather.

Section (b).—This happened upon 6 occasions, and upon 2 of them rain followed. The argument under Section (a) holds good in this one.

PREDICTION.—Probable wet weather.

Section (c).—We have 8 cases, 3 of which were followed by rain, but the falls were slight and unexpected.

PREDICTION.—Dry weather.

DIVISION (2).

Section (a).—Only 2 cases.
Section (b).—Only 1 case.
Section (c).—Only 2 cases.
The majority of these cases were followed by dry weather.

PREDICTION for Division.—Dry weather.

DIVISION (3).

Section (a).—Out of 7 cases, only 2 were followed by rain; wind was easterly.

Section (b).—Here we have 11 cases, rain following only after 1 of them.

Section (c).—Out of 10 cases, only 2 were followed by rain, and then not more than 0·02 in. fell.

PREDICTION for Division.—Dry weather.

By applying the result of the foregoing investigation to the rainfall returns of 1908, I arrive at the following:—

Under this group there were 191 cases, 15 of which I included as failures, being 7·8 per cent. But inasmuch as upon 5 occasions our common sense would have made us relegate some of the cases to other sub-groups, we get the total number of absolute errors, or failures, as 10, making 5·23 per cent. of the total number of cases. I think this is proof enough of the value of the argument.

GROUP II.—GENERAL PRESSURE INCREASING.

SUB-GROUP (A).

By examining the triangle, it will be seen that when pressure increases at L'Agulhas more than at the other two stations, it is either due to an anticyclone passing to the south of the Cape or to the fact that increase of pressure generally is retarded by summer conditions to the north. This is more noticeable when Clanwilliam has the least increase. Sometimes the barometer at Clanwilliam actually falls when the other two are rising, and this brings the condition into relationship with that under Sub-Group 1, (G).

In this Sub-Group the actual highest pressure bears a direct influence on the following weather; the normal condition is a rising barometer at each station, with the actual lowest reading at Clanwilliam and the highest at L'Agulhas; such denote pure summer type conditions, and it depends entirely upon the height of the barometer whether these conditions are due to a depression to the north or an anticyclone to the south. Should the actual reading be lowest at L'Agulhas, it is evident that winter type conditions are making themselves felt, possibly a depression has just passed with a very low reading at that station, so that the excess of increase in pressure is only apparent; in such a case rain would be probable. In all predictions this condition must be taken into account, and if it exists the probability of rainfall should be mentioned.

DIVISION (1).

Section (a).—Here we have only 3 cases, 1 being followed by rain and the other 2 by dry weather; the former was a fall of 0·13 in. following a deep summer type depression, where no rain would have been expected.

Section (b).—There are 10 cases, 2 being followed by rain; on 1 of these only 0·02 in. fell, and the other was due to a winter type depression.

Section (c).—This happened upon 83 occasions, and only upon 3 did rain follow.

PREDICTION for Division.—Dry weather.

DIVISION (2).

Section (a).—Here we have 2 cases, followed by dry weather.

Section (b).—Here are 14 cases, and rain followed upon 5 of them. The rainfall on each of these 5 occasions was entirely due to a recently passed winter type depression.

Section (c).—This condition came upon 86 occasions, and on 78 of them dry weather followed; on 4 of the wet days less than 0·05 in. fell, so we have only 4 actual failures.

PREDICTION for Division.—When pressure is mean at L'Agulhas and a winter type depression has just passed, look out for rain, both at the Royal Observatory and at L'Agulhas; in all other cases prepare for dry weather.

DIVISION (3).

Section (a).—1 case followed by rain.

Section (b).—1 case followed by rain.

Section (c).—Out of 22 cases, 12 were followed by rain and 10 by dry weather; this is an unnatural condition, blending winter with summer types, the rapid rise at L'Agulhas being the summer type and the high barometer at Clanwilliam the winter one.

PREDICTION for Division.—When a winter type depression is passing off and the glass is low at L'Agulhas, rain can be expected; otherwise prepare for dry weather.

SUB-GROUP (B).

This can be brought about by a wedge of high pressure pushing up from the south of L'Agulhas, reaching to Clanwilliam. Or, again, a recovery of pressure at the rear of a depression may be interfered with by a secondary to the west or north-west of the Royal Observatory.

DIVISION (1).

Section (a).—No cases.

Section (b).—We have only 2 cases, followed by dry weather.

Section (c).—This happened upon 34 occasions, and only once did rain fellow.

PREDICTION for Division.—Dry weather.

DIVISION (2).

Section (a).—No cases.

Section (b).—There were only 2 cases, 1 followed by rain.

Section (c).—Here we have 5 cases, only 1 being followed by rain, and then only 0·03 in. fell.

PREDICTION for Division.—Dry weather.

DIVISION (3).

Section (a).—No cases.

Section (b).—Only 2 cases, followed by dry weather.

Section (c).—This happened upon 9 occasions, and rain followed 7 of them; on the 2 excepted days pressure was very high and no rain would have been looked for. In the cases where rain followed, although pressure was high at Clanwilliam, it fell towards L'Agulhas, and was akin to winter type conditions.

PREDICTION for Division.—Wet weather. Exception.—High pressure all over.

SUB-GROUP (C).

This can be brought about by a high-pressure area pushing up from the south, or a depression to the north-west preventing proper recovery after a winter type depression has passed.

DIVISION (1).

Section (a).—No cases.

Section (b).—Here we have 6 cases, each followed by dry weather.

Section (c).—This happened 48 times, and only after 1 of them did rain follow.

PREDICTION for Division.—Dry weather.

DIVISION (2).

Section (a).—No cases.

Section (b).—There are only 2 cases, each followed by dry weather.

Section (c).—Here we have 12 cases, 10 of which were followed by dry weather; on the remaining days only 0·02 in. fell on each day.

PREDICTION for Division.—Dry weather.

DIVISION (3).

Section (a).—No cases.

Section (b).—We have but 3 cases, 2 followed by rain.

Section (c).—This condition prevailed upon 13 occasions; after 7 of them rain fell, and after 6 dry weather followed. From a consideration of all the cases, I have come to the conclusion as follows:—

PREDICTION for Division.—

Pressure at Clanwilliam below 30·10 in., wet.
,, ,, ,, 30·10 in. to 30·20 in., doubtful.
,, ,, ,, above 30·20 in., dry.

SUB-GROUP (D).

This would be brought about by an advancing high-pressure area moving from the west and just skirting Clanwilliam. Of course the actual increase in pressure at the Royal Observatory may only be apparent, and other conditions may be at work causing rain; these will be considered in their places, but the main influence of the group leads to fine, dry weather.

DIVISION (1).

Sections (a), (b).—No cases.

Section (c).—Here we have 5 cases, and dry weather followed each.

PREDICTION for Division.—Dry weather.

DIVISION (2).

Section (a).—There are 3 cases, each followed by dry weather.

Section (b).—There are 9 cases, each followed by dry weather.

Section (c).—This happened upon 35 occasions, and upon 27 of them dry weather followed. Of the 8 remaining, less than 0·05 in. fell upon 6 days, and on the remaining 2 days rain would not have been expected.

PREDICTION for Division.—Dry weather.

DIVISION (3).

Section (a).—No cases.

Section (b).—There are only 2 cases, 1 followed by dry, and the other by wet weather.

Section (c).—We have 8 cases, 6 being followed by rain; on the 2 other occasions clearing-up showers after a winter type depression would have been looked for.

PREDICTION for Division.—Wet weather.

SUB-GROUP (E).

This can be brought about by a high-pressure area approaching from the west or north-west, leaving the gradient at L'Agulhas open to the south and south-east. Of course, as in other groups, pressure might have been exceptionally low to the west or north-west, causing the rapid rise to appear as a bank of approaching high pressure, when such was not the case.

DIVISION (1).

One case in each section, followed by dry weather.

PREDICTION for Division.—Dry weather.

DIVISION (2).

Section (a).—Here we have 3 cases; 2 were followed by dry weather, and 1 by rain; the conditions were not for rain, and only 0·05 in. fell, although it rained at L'Agulhas.

Section (b).—This happened upon 16 occasions, rain following only twice; on one of these occasions the fall was only 0·02 in.

Section (c).—This condition was present upon 26 occasions, and after 20 of them dry weather followed; out of the 6 exceptions only 1 was abnormal, and no rain would have been predicted; the other 5 were due to the fact that winter type depressions had just passed, and the glass at L'Agulhas was low; in none of these 5 cases did much rain fall at the Royal Observatory, but in each rain fell at L'Agulhas.

PREDICTION for Division.—Dry weather. Exception.—Winter depression at L'Agulhas.

DIVISION (3).

I shall refer to this later on.

SUB-GROUP (F).

Similar conditions to those affecting Sub-Group (E) can bring about this, with a high-pressure area pushing from the west or south-west and wedging across the peninsula.

DIVISION (1).

Section (a).—Only 1 case.

Section (b).—No cases.

Section (c).—There were only 3 cases, 2 being followed by very slight rainfall.

Prediction for Division.—(Provisionally)—Dry weather.

DIVISION (2).

Section (a).—Only 1 case.

Section (b).—Here we have 4 cases, followed by dry weather.

Section (c).—This happened upon 18 occasions, and after 13 of them dry weather followed; out of the 5 exceptions the falls were below 0·05 in. 3 times, and the other 2 were abnormal, and no rain was expected.

Prediction for Division.—Dry weather.

DIVISION (3).

Sections (a), (b).—No cases.

Section (c).—There were 6 cases, and only 1 followed by dry weather; on this day rain was expected.

Prediction for Division.—Wet weather.

SUB-GROUP (G).

Here we have conditions bearing a relationship to Sub-Group 1, (A); where L'Agulhas falls most and Clanwilliam least. In some cases it will be seen that the barometer at L'Agulhas actually falls while others rise, and these will be specially considered. This condition is one which succeeds the passing of a winter type depression, or the advance of high-pressure areas from the north or north-west; sometimes a high-pressure area is pushing down from the north or north-west while a depression is affecting the south, and we have thus a complication.

DIVISION (1).

Section (a).—Only 1 case.

Section (b).—Only 2 cases, followed by dry weather.

Section (c).—Only 2 cases, followed by dry weather.

PREDICTION for Division.—Dry weather.

DIVISION (2).

Section (a).—There are only 2 cases, 1 followed by dry weather, and 1 by a fall of only 0·01 in.

Section (b).—Here we have 4 cases, 1 of which was followed by rain; but only 0·06 in. fell.

Section (c).—There were 12 occasions when this condition occurred, and after 3 of them rain followed, but in each case it was less than 0·05 in.

PREDICTION for Division.—Dry weather. Exception.—A winter depression at L'Agulhas.

DIVISION (3).

I shall refer to this later on.

SUB-GROUP (H).

This can be brought about by the formation of a high-pressure area to the north, retarded by a disturbance to the west of the Royal Observatory.

DIVISION (1).

Sections (a) (b).—No cases.

Section (c).—We have 5 cases, each followed by dry weather.

PREDICTION for Division.—Dry weather.

DIVISION (2).

No cases.

DIVISION (3).

Section (a).—No cases.

Section (b).—Only 2 cases, followed by rain.

Section (c).—Here we have 4 cases, followed by dry weather only on 1 of them.

PREDICTION for Division.—Wet weather.

SUB-GROUP (I).

Similar conditions to those under Sub-Group (H) are here indicated.

DIVISION (1).

Section (a).—There are only 2 cases, followed by dry weather.

Section (b).—Only 3 cases, 1 followed by rain.

Section (c).—There were 5 occasions with this condition, and only on 1 day did 0·01 in. of rain fall.

PREDICTION for Division.—Dry weather.

DIVISION (2).

Section (a).—No cases.

Section (b).—Only 2 cases, followed by dry weather.

Section (c).—Here we have 4 cases, 1 being followed by rain.

PREDICTION for Division.—Dry weather.

DIVISION (3).

Section (a).—Only 1 case, followed by rain.

Section (b).—We have 5 cases, 4 being followed by rain; on the excepted day rain was expected, and it rained at L'Agulhas.

Section (c).—This happened upon 5 occasions, 3 being followed by rain and 2 by dry weather; the 2 exceptions were due to the fact that the movement was merely a fluctuation in an anticyclone in each case.

PREDICTION for Division.—Dry weather. Exception.—Fluctuation in an anticyclone.

SUB-GROUP (J).

This is a condition which can follow in the rear of a winter type depression, or it may be that such a depression is still at L'Agulhas and pressure banking up to the north-west. Again, it may be due to the banking up on the north-west of an existing high-pressure area. It is akin to Sub-Group (G).

DIVISION (1).

Section (a).—There is only 1 case.

Section (b).—Only 2 cases, followed by dry weather.

Section (c).—Here we have 5 cases, only 1 of which was followed by rain, and then none was expected.

PREDICTION for Division.—Dry weather.

DIVISION (2).

Section (a).—Only 1 case.

Section (b).—We have 9 cases, only 2 of which were followed by rain.

Section (c).—This happened upon 18 occasions, and rain followed only upon 2 of them; the falls were 0·03 in. and 0·02 in. respectively.

PREDICTION for Division.—Dry weather.

DIVISION (3).

I shall refer to this later on.

SUB-GROUP (K).

This can be brought about by the formation of an anticyclone or the fact that the high-pressure area following a depression is affected by some disturbance to the north-west or west.

DIVISION (1).

Sections (a), (b).—No cases.

Section (c).—Here we have 14 cases, all followed by dry weather.

PREDICTION for Division.—Dry weather.

DIVISION (2).

Section (a).—No cases.

Section (b).—Only 1 case.

Section (c).—There are 8 cases, of which only 1 was followed by rain.

PREDICTION for Division.—Dry weather.

DIVISION (3).

Section (a).—No cases.

Section (b).—There were 3 cases, 1 followed by rain and 2 by dry weather; each case was a rain-bringing one, as a winter type depression had just passed and pressure was low at L'Agulhas.

PREDICTION.—Wet weather.

Section (c).—Here we have 4 cases, 1 being followed by rain.

PREDICTION.—Dry weather.

SUB-GROUP (L).

This is due principally to the banking up of pressure to the south-west, and it is sometimes accompanied by the presence of a summer type depression to the north. It is also brought about through recovery of pressure after a winter type depression has passed.

DIVISION (1).

Section (a).—No cases.

Section (b).—There are 5 cases, each followed by dry weather.

Section (c).—Here we have 8 cases, only 1 of which was followed by rain.

PREDICTION for Division.—Dry weather.

DIVISION (2).

Section (a).—Only 1 case.

Section (b).—There are 12 cases, and only 2 were followed by rain.

Section (c).—Here we have 21 cases, and of these 16 were followed by dry weather; of the remaining 5 cases, 1 had a fall of 0·05 in. and the other 4 less.

PREDICTION for Division.—Dry weather.

DIVISION (3).

Section (a).—Only 2 cases, 1 followed by rain.

Section (b).—This happened upon 11 occasions, and after 7 of them rain followed; the weather conditions of the remaining 4 were such as would have caused one to look for rain.

Section (c).—Here we have 11 cases, 6 followed by rain and 5 by dry weather; in each of these cases a winter type depression had just passed, and clearing up showers would have been looked for.

PREDICTION for Division.—Probable wet weather.

SUB-GROUP (M).

This can come about at the rear of a depression, or when an anticyclone or low-pressure area alters its level generally.

DIVISION (1).

Section (a).—3 cases, 1 followed by rain and 2 by dry weather; the rainfall was only 0·05 in.

Section (b).—2 cases, followed by dry weather.

Section (c).—6 cases, followed by dry weather.

PREDICTION for Division.—Dry weather.

DIVISION (2).

Section (a).—No cases.

Section (b).—There are 7 cases, 2 only being followed by rain, but in neither case did the fall go beyond 0·02 in.

Section (c).—There are 13 cases, and only 1 of them was followed by rain.

PREDICTION for Division.—Dry weather.

DIVISION (3).

Section (a).—2 cases, 1 followed by rain and 1 by dry weather; in the latter case rain should have followed.

PREDICTION.—Wet weather.

Section (b).—4 cases, 2 followed by rain.

PREDICTION.—When a winter type depression is passing away, look for wet weather. When a summer type depression is passing, predict dry weather.

Section (c).—There are 9 cases, 3 followed by rain and 6 by dry weather. Of the 3 cases the falls were 0·01 in. and 0·02 in. respectively upon 2 days; the other case was abnormal.

PREDICTION.—Dry weather.

We now come to an important group, namely, Division (3) from each of the Sub-Groups (E), (G), and (J); these we must place together, owing to their similarity of conditions.

Let us first get at the actual facts.

SUB-GROUP (E).

Section (a).—2 cases, 1 followed by rain.

Section (b).—3 cases, each followed by rain.

Section (c).—5 cases, each followed by rain.

SUB-GROUP (G).

Section (a).—5 cases, rain following only after 1.

Section (b).—24 cases; on all but 1 wind was west; on 13 days rain followed and after 11 dry weather.

Section (c).—22 cases, 12 followed by rain and 10 by dry weather; on 19 days wind was westerly.

SUB-GROUP (J).

Section (a).—3 cases, followed by dry weather.

Section (b).—8 cases, 5 followed by rain.

Section (c).—13 cases, 8 followed by dry weather and 5 by rain.

I have considered each one of these cases, and have been able to place them under the following heads:—

(T) When a winter type depression is approaching from the south-west, and an area of high pressure is forming to the north.
(U) When a winter type depression has passed on the previous day.
(V) When a winter type depression has passed two days previously.
(W) When the centre of such a depression is at L'Agulhas, but recovery set in elsewhere.
(X) When a summer type depression has passed from the north to L'Agulhas.
(Y) Anticyclonic movements.
(Z) When a winter type depression impinges on an anticyclone.

By tabulating all cases we get the following:—

Case	T	U	V	W	X	Y	Z
Wet	—	13	2	22	4	1	2
Dry	1	7	3	5	17	6	1
Prediction	Dry	Wet	?	Wet	Dry	Dry	Wet

If we now apply the results of our investigation to the rainfall returns of 1908 we arrive at the following:—

Under this group there were 166 cases, 18 of which were apparently failures, making 10·9 per cent. (say, 11 per cent.) of the total number of cases. At the same time it is worth mentioning that of the 18 cases of failure, 14 were such as might, by exercising a little common sense, have been relegated to other sub-groups, and at any rate have considerably modified the predictions.

ON SOME POINTS IN THE MORPHOLOGY AND BIOLOGY OF A NEW SPECIES OF *HAWORTHIA*.

By S. Schönland, Ph.D., F.R.S.S.Af.

(Plate XXVI.)

(Read June 16, 1909.)

Haworthia truncata, Schönl., n. sp.

Radices carnosi elongati. Caulis brevissimus carnosus. Folia 2–5 stricte disticha 2–3 cm. longa medio circ. 17 mm. lata carnosa applanata ovato-deltoidea truncata suberecta leviter incurvula, apice faciem suboblongam medio constrictam tuberculis minutis rugosam exhibientia, supra apicem versus convexa longitudinaliter canaliculata tuberculis minutis rugosa infra vaginantia concava lævia ad margines tenuiter denticulato-ciliata, subtus convexa medio longitudinaliter leviter canaliculata superne tuberculis minutis rugosa. Pedunculus erectus gracilis simplex filiformis, e basi vacue bracteatus incl. racemo laxo 20–25 cm. altus. Bractei ovato-acuminati membranacei 4–5 mm. longi pedicellis subæquantes. Perigonium c. 10 mm. longum albidum obscure striatum tubo subventricoso segmentis bilabiatis. Stylus ovario triplo brevior. Capsula oblonga, triquetra, 8 mm. longa, semina 3 mm. longa irregulariter subtriquetra.

On a farm, 7 miles from Oudtshoorn, Miss L. Britten, B.A., April, 1909.

This new species is very interesting from several points of view, on some of which I beg to offer a few remarks. It is evidently allied to the species which have been placed under the sections *Venosæ, Berger*, and *Retusæ*, Haw.*

In the first place, it is the only species of *Haworthia* hitherto known with bifarious arrangement of leaves. However, in the allied genus *Aloe* there are several species which show this arrangement, although the majority of species, when adult, have multifarious leaves, and in another genus, *Gasteria*, it is quite common. There is nothing to indicate whether

* See A. Berger, "Liliaceæ—Asphodeloideæ—Aloineæ," in Engler's "Pflanzenreich," Heft. 33, 1908, pp. 97, 99.

such species with distichous leaves represent ancient types, or whether they show simply a reversal to a more primitive type.

From the appearance of the specimens as they reached me, it seemed that the stem and a portion of the leaves are underground, so that only a very small portion of the upper rugose part of the leaves and the inflorescence are exposed,* and Miss Britten later informed me that this is certainly the case.

It does not require much imagination to come to the conclusion that the exposed parts resemble, to a large extent, pebbles of stone, and most likely the plant derives a considerable amount of protection from its partly hypogean habit. I would, therefore, suggest that it has to be classed with the so-called "mimicry" plants to which Burchell,† Marloth,‡ and Thiselton-Dyer§ have called attention. It would thus be the first monocotyledonous plant belonging to this category, but I believe several other species of *Haworthia* are similarly protected. *H. truncata* is not the only species of its genus which buries itself to a certain extent underground. Several species of the sections *Venosæ* and *Retusæ* do this also to a considerable extent. In our species the roots showed decided transverse wrinkles, and it is therefore safe to conclude that they are contractile, and draw the plant gradually into the ground as the stem elongates at the top, while its older portions die off. In the stemless species of *Aloe* the stem is also constantly pulled into the ground by adventitious roots,‖ though this may not show itself in specimens cultivated in pots. Thus in our species the stem and the greater portion of the leaves remain buried, while only the rugose portion of the leaves protrudes aboveground. The underground parts of the leaves continue, however, to act as assimilating organs, and the median channels on the back and front of the leaves no doubt help to facilitate an interchange of gases, while arrangements against excessive transpiration are ample. Stomata, which, as in other members of the genus, are sunk below the surface, are found scattered chiefly in the lower portion of the leaves. They decrease towards the apex, and are quite absent on the flat top. Longitudinal sections show that, while the assimilating tissue is arranged along the side-walls, the apex and centre are quite free from chlorophyll. There is a strong cuticle covering the whole of the leaf. It is especially thick in the upper third. The small tubercles in the upper flat portion are several-celled and *impede*, to a certain extent, the light entering the leaf, as I could make

* Similar largely underground foliage leaves are found in *Mesembrianthemum* (§ *Sphæroidea*) and in *Bulbine mesembrianthemoides*.

† "Travels in the Interior of Southern Africa," i., p. 210.

‡ *Trans. S. Afr. Phil. Soc.*, xv., 1904, p. 97; xvi., 1905, p. 165; xviii., 1907, p. 281.

§ *Annals of Botany*, xx., p. 124.

‖ A. Berger, l.c., p. 4.

out by means of a few simple experiments. The assimilating tissue is represented by several layers of spongy parenchyma, in which at intervals, arranged in two rows, longitudinal sacs of rather long raphides of oxalate of lime can be seen. Adjoining the assimilating tissue are the vascular bundles in which sclerenchymatous elements are absent. The greater part of the interior is occupied by a thin-walled very transparent water-storing tissue. The whole structure resembles to such a remarkable degree Berger's figure* of a longitudinal section of *H. retusa* that at first sight I thought it represented our species. Both in this species and in ours very little light can enter the leaf except through the chlorophyll-free top, its "window." Similar arrangements, though somewhat modified, are found in many other species of *Haworthia*, *H. retusa*, and *H. truncata* being extreme cases. Now, in the description to his figure, Berger adduces *H. retusa* as an example of a structure in which the light is made use of to the greatest extent, while in the same figure he represents two other species covered with tubercles, which protect these species against too much light. It seems extraordinary that species of the same genus, provided they are living under similar conditions, should show such remarkable differences, some species being protected against excessive light, while others have special arrangements to make use of it. However, the apparent contradiction seems to be capable of an easy explanation. It is more and more recognised that plants cannot make use of intense sunlight; in fact, their chloroplasts require protection against excessively intense light (compare, *e.g.*, Schimper, "Plant Geography," Engl. Ed. p. 58). We have very little exact knowledge on this point yet, but the researches of Wiesner (see, *e.g.*, J. Wiesner, "Der faktische Lichtgenus der Pflanzen, Ber. d. d. bot. Ges., 1894, Generalversammlungsheft," p. 78), have shown that in the majority of plants the amount of light actually enjoyed is very much less than the amount available. Schimper points to the fact that the vegetation of very sunny spots is never pure green, and exhibits an admixture of yellow and brown tints due to the products of decomposition of chlorophyll,† but on the whole he does not think that land plants generally require very elaborate protection against excessive light, and yet an enormous number of our plants show almost at the first glance that only a small fraction of the sunlight which is at their disposal can be really utilised by them. Hairs, waxy covering, mutual shading of parts, succulency, and a host of other contrivances are to be found which must considerably reduce the light reaching the assimilating tissues.

* Berger, l.c., p. 12, fig. 7, D.

† Marloth, on p. 218 of his recently published magnificent work "Das Kapland, insonderheit das Reich der Kapflora, das Waldgebiet und die Karroo pflanzengeographisch dargestellts" (Jena, 1908), has incidentally emphasised this point with reference to many Karroo bushes. "There is no trace of green, even the scanty small leaves have the same nasty colour as the wood. Brown is the colour of the Karroo."

These contrivances are usually also calculated to reduce transpiration very considerably, and their function in this direction is undoubtedly of vital importance to the plant, but at the same time the fact that they reduce the light has hitherto, as a rule, not received that attention which it deserves. A large number of our South African plants, although apparently exposed to the fierce rays of the sun, are really *physiological shade-plants.**

Now *H. truncata* has actually retired into the shade by burying itself to a large extent underground, and as the basal part of the leaf still acts as an assimilating organ, some provision is necessary for the light to reach it at all, and the light can only reach it through the "window" which is at the top. It does not require any learned calculations to show that the amount of light entering through such a window cannot be very great, and, moreover, the window-pane is not quite clear. I abstain from making any remarks on other species of *Haworthia* with similar "windows," as I have not observed them amongst their natural surroundings,† and have no precise information as to how they grow under those conditions, nor can I say anything about the peculiar *Bulbine mesembrianthemoides* which I have not seen alive.

* O. V. Derbyshire, in his "Observations on *Mamillaria elongata*" (*Annals of Botany*, xviii., p. 375), concludes that the papillæ on some species of *Mesembrianthemum*, and the terminal bristles on others, serve also the purpose of diminishing the light that reaches the assimilating tissues. I hope to be able to refer to his conclusions more in detail before long, as I am conducting a series of experiments which are calculated to throw light on them. In the meantime I should like to state my opinion that they seem to me to require clear experimental proof before they can be accepted in their entirety.

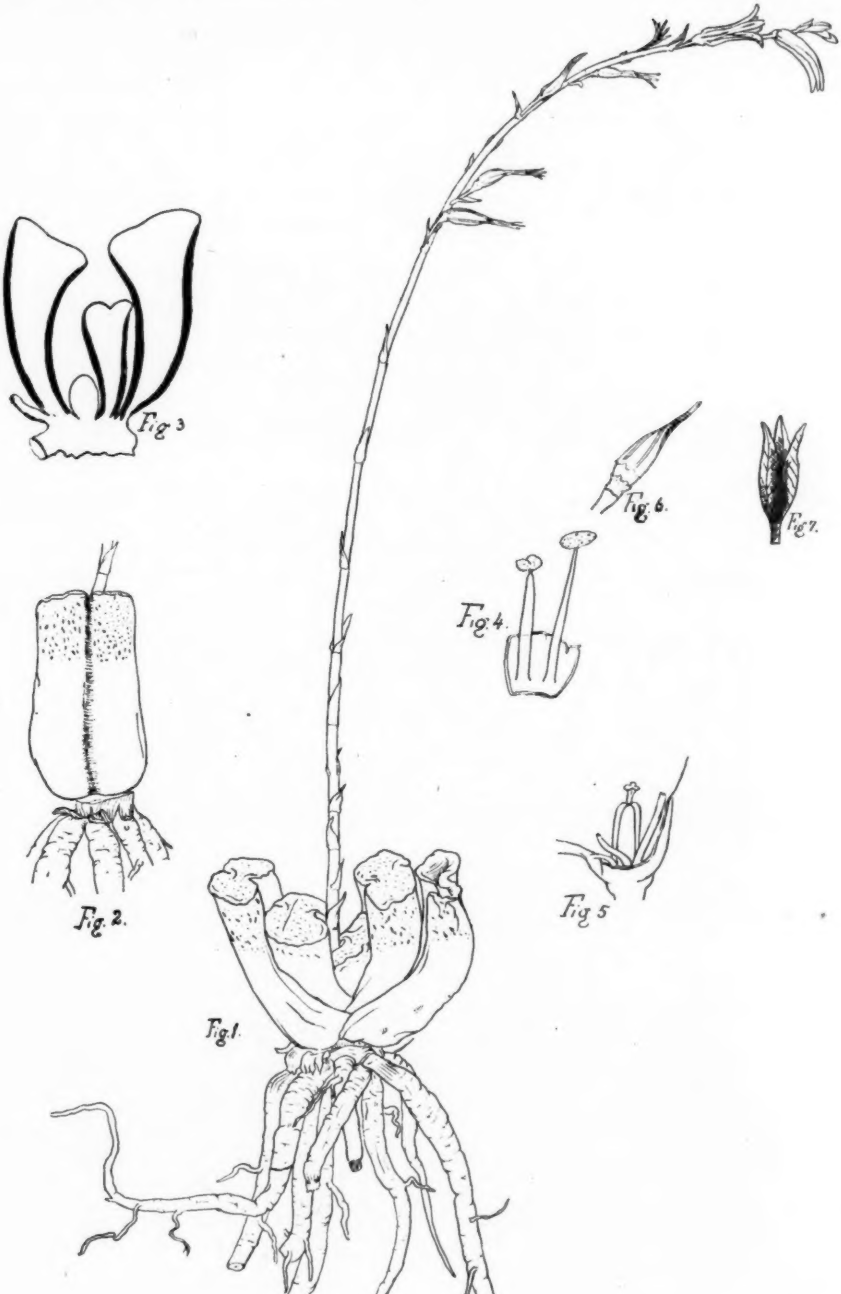
† The whole argument of Berger's that these plants have arrangements which secure an improved supply of light, and which do not serve as a protection against intense light, appears to me, however, quite wrong without a similar explanation as I have given for *H. truncata*.

DESCRIPTION OF PLATE.

Haworthia truncata, Schönl., n. sp.

FIG.

1. Whole plant (natural size).
2. Dorsal view of leaf with tops of roots and base of peduncle (natural size).
3. Median longitudinal section of leaves and stem. The thick black lines in the leaves indicate the extent of the assimilating tissue (natural size).
4. Two stamens and portion of the corolla (about 3/1).
5. Gynæcium, &c. (about 3/1).
6. Young capsule, with corolla still attached (natural size).
7. Ripe open capsule (natural size).



E. Wormald del.

West, Newman proc.

HAWORTHIA TRUNCATA, *Schönl.*

ON THE ABSORPTION OF WATER BY THE AËRIAL ORGANS OF SOME SUCCULENTS.

By S. Schönland, Ph.D., F.R.S.S.Af.

(Read June 16, 1909.)

Ever since the absorption of water by plants has been the subject of experimental inquiry, it has been known that water in liquid form can be absorbed by the leafy shoots of many plants, and that even the loss by transpiration of other parts of the same plant, which are not wetted, can be made good in this manner.* However, the shape and arrangement of leaves on the axis is frequently such as to prevent or hinder the formation of dew upon them.† Rain is usually easily drained off, and can, as a rule, not readily lodge on them. The absorption of liquid water by aërial parts of plants under artificial conditions is, therefore, in the majority of plants, only of academical interest. On the other hand there are cases, *e.g.*, the epiphytic *Bromeliaceæ*, in which the plants are either without roots or provided with an imperfect root-system, and in which, therefore, absorption of water by aërial parts becomes a necessity. To a limited extent the utilisation of rain-water and dew may also occur in other plants, *e.g.*, in cases where the leaf-sheaths collect a considerable amount of water. There remain a number of other cases in which water is supposed to be absorbed by means of special hairs or glands or by means of saline excretions of the leaves. Marloth ‡ has shown pretty conclusively that the saline excretions cannot serve to conduct water from rain or dew to the organs which secrete them. In his recently published

* See L. Kny, "Uber die Anpassung von Pflanzen gemässigter Klimate an die Aufnahme tropfbarflüssigen Wassers durch oberirdische Organe," Ber. d. d. bot. Gesellschaft, iv. (1886), p. xxxvi (where the literature up to that time is pretty fully quoted), and "Ueber die Aufnahme tropfbar-flüssigen Wassers durch winterlich-entlaubte Zweige von Holzgewächsen," Ibid. xiii. (1895), p. 361.

† Stahl, "Annales Jard. Buitenzorg," ii. (1893), p. 98, as quoted by Jost, "Lectures on Plant-Physiology," Engl. Ed. (1907), p. 32.

‡ R. Marloth, "Zur Bedentung der Salz abscheidenden Drüsen der Tamariscineen," Ber. d. d. bot. Gesellschaft, v. (1887), p. 319.

work on the Cape Flora* he gives, however, some prominence to the absorption of water by special trichomes of certain succulents. Some cursory experiments, which I have conducted from time to time, do not bear out his views in this matter.† That many succulents may take up water through their aërial organs under special conditions arranged for them need not surprise us, for we have the old experiment by Wiesner that *Sedum Fabaria* can do so, but there is always to be remembered that such experiments have very little interest, unless they show us that the plant *under natural conditions* can replace more or less by its aërial organs the amount of water lost by transpiration. The experiments which I am going to describe were conducted to throw some fresh light on this question. While they cannot be regarded as the last word, even with reference to the limited number of plants experimented with, the answer they give is sufficiently plain to merit consideration.

I experimented with cut branches taken in each species from the same plants. These have the advantage that, when selected with reasonable care, they are in the same condition as regards water-contents. The cut stem can easily be sealed and the whole branches can easily be weighed on an ordinary chemical balance. They were taken from pot-plants which had been regularly watered when required. Except in cases which will be specially mentioned the cut end of each branch was at once carefully sealed with plasticine, to which a small quantity of vaseline had been added. Some of the branches were exposed on a table in the Botanical Laboratory of the Rhodes University College where the sun shone on them for several hours every day, others were exposed in the open, where the sun shone on them also for several hours, and where dew could be deposited on them. The position in the open was somewhat sheltered from strong westerly winds, which blew on several days. Temperature-readings were taken occasionally, but as these could not be taken with sufficient regularity day and night, they are here omitted. It may suffice to state that the laboratory temperature ranged from 14–19° C. in daytime. From the 15th to the 23rd of May the weather was rather warm for the time of year, while it was much cooler during the following week and warm again the third week. Altogether transpiration was necessarily much smaller than in the height of summer, while absorption of water, if taking place at all, would probably not be greatly affected by differences in temperature. There was a heavy dew every night, but only a slight rain fell in one night for a couple of hours, while branches were exposed in the open.

* R. Marloth, "Das Kapland, insonderheit das Reich der Kapflora, das Waldgebiet und die Karroo, pflanzengeographisch dargestellt," June, 1908.

† S. Schönland, "Morphological and biological observations on the genus *Anacampseros*, L." Report S.A.A.A.S., 1903, p. 298.

The fact that the cut ends of the branches were in most cases sealed with plasticine introduces a slight inaccuracy into the percentage of losses and gains, but they are not serious enough to vitiate the general conclusions which we can draw from them.

MESEMBRIANTHEMUM BARBATUM, L.

Two branches, each with eight leaves.

I.

Kept in laboratory, a drop of water placed daily on the stellate hairs.
16/5/09 Weight, ·391 gr.
23/5/09 Weight, ·282 gr. — Loss in weight, ·109 gr. = 27·9 per cent.

From May 23rd kept in the open, immersed daily for 15 minutes in water.
29/5/09 Weight, ·242 gr. — Further loss, ·040 gr. = 10·2 per cent. of original weight.
Total loss, 38·1 per cent.

II.

Kept dry in laboratory.
16/5/09 Weight, ·498 gr.
23/5/09 Weight, ·390 gr. — Loss in weight, ·108 gr. = 22·1 per cent.

Kept further in the laboratory, but immersed daily in water for 15 minutes, except on the last day when immersion lasted 5 hours.
29/5/09 Weight, ·361 gr. — Further loss, ·039 gr. = 7·9 per cent. of original weight.
Total loss, 30 per cent.

It is strange that in the specimen in which the hairs were moistened daily, the loss of water was greater than in the one which was kept dry. The same curious result was obtained with *Anacampseros filamentosa*. Whether this is only a coincidence has to be decided by further experiment. In any case it seems clear that the plant cannot make use of water placed on the stellate hairs, nor does exposure to dew and immersion to the extent to which the plant was subjected make good the loss of water by transpiration.

ANACAMPSEROS FILAMENTOSA, Sims.

Two branches.

I.

Kept in laboratory, hairs moistened daily.
16/5/09 Weight, 6·211 gr.
23/5/09 Weight, 5·602 gr. — Loss, ·609 gr. = 9·8 per cent.

From 23/5 09 kept in the open, but immersed daily for 15 minutes in water.
29/5/09 Weight, 5·071 gr. — Further loss, ·531 = 8·5 per cent. of original weight.
Total loss, 18·3 per cent.

II.

Kept dry in laboratory.
16/5/09 Weight, 9·277 gr.
23/5/09 Weight, 8·672 gr. — Loss, ·605 gr. = 6·5 per cent.

Kept further in the laboratory, but immersed daily in water for 15 minutes, except on the last day when immersion lasted 5 hours.
29/5/09 Weight, 9·011 gr. — Gain, ·339 gr.,* which still leaves a loss of ·266 gr. = 2·9 per cent. as compared with the original weight.

Crassula cymosa, L.

Four branches.

I.

Exposed in the open, but otherwise not interfered with.
23/5/09 Weight, 5·62 gr.
29/5/09 Weight, 5·202 gr. — Loss, ·418 gr. = 7·5 per cent.

II.

Exposed in the open, but immersed every day in water for 15 minutes.
23/5/09 Weight, 7·217.
29/5/09 Weight, 6·71. — Loss, ·507 gr. = 7 per cent.

III.

Kept in laboratory, but not interfered with.
23/5/09 Weight, 7·125 gr.
29/5/09 Weight, 6·29 gr. — Loss, ·835 gr. = 11·6 per cent.

IV.

Kept in laboratory and immersed daily in water for 15 minutes, except on the last day when immersion lasted 5 hours.
23/5/09 Weight, 8·591 gr.
29/5/09 Weight, 7·864 gr. — Loss ·727 gr. = 8·5 per cent.

Exposure to dew and immersion did not prevent considerable loss, though immersion conferred a slight advantage on branches subjected to it.

* This gain will be referred to again later on.

Experiments with Eosine Solution.

On the 23/5 freshly cut branches of *Mesembrianthemum barbatum* and *Anacampseros filamentosa* were dipped in a strong, watery solution of eosine and left in the solution for twenty-four hours. In the first the stellate hairs were stained, everything else was unstained. This was confirmed by microscopic examination. In *Anacampseros* the long hairs were stained, everything else looked normal. Microscopical examination showed that no eosine had penetrated into stem or leaves. On the 24/5 branches of all three kinds of plants experimented with were cut and left dry in the laboratory. The cut ends were not sealed in this case. All except *Anacampseros* showed external signs of withering on the 29/5; on that date their upper portions were dipped in eosine solution and left for twenty-four hours, after which they were examined. The result was as follows:—

Anacampseros: Hairs distinctly stained, otherwise no sign of red, either externally or internally.

Mesembrianthemum: Except stellate hairs, no part showed either externally or internally any signs of red.

Crassula: Papillæ faintly stained, vascular bundles in leaves and stem distinctly red, nothing else stained.

Thus this test only showed penetration of watery eosine solution in *Crassula cymosa* after the branches had been kept dry for nearly a week with the cut ends not sealed.

It seemed desirable, therefore, to determine in the first place whether the gain previously mentioned in *Anacampseros* after immersion in water for five hours was due to the fact that the water was sucked up by the hairs as by a sponge or whether the leaves themselves had absorbed it. The same two branches were therefore again weighed on the 30/5, and it was found that while the one that had on the previous day been soaked for five hours had lost 8·3 per cent. of its weight the other, which had only been dipped for fifteen minutes, lost only 4·4 per cent. of its weight. They were then both immersed for twenty-five minutes in eosine solution and then weighed after having been dried as carefully as possible with blotting-paper. The former then showed actually a small gain on the previous day's weight; it weighed 9·164 gr., while the latter weighed 5·044 gr., which was a little less than the day before. However, no sign of red could be found in the interior of the plant, and this, in conjunction with the other facts mentioned, seems to show pretty conclusively that, as in *Mesembrianthemum barbatum*, no appreciable quantity of liquid water can enter the aërial organs from without. The gain in *Anacampseros* was evidently due to the absorption of water by the long, dead hairs and not by the leaves themselves. This gain is readily acquired, but also readily

parted with. Such a wet sponge on the leaves will undoubtedly serve to retard transpiration, and in this connection the use of the hairs is obvious. There remains now only *Crassula cymosa*, into which eosine had penetrated in the experiment previously described.

Four branches of *Crassula cymosa* were cut on June 1st. Three had their cut ends sealed, one had not. Though still quite healthy, all showed decided signs of withering on June 6th. They were then immersed in strong, watery eosine solution for twenty-four hours, except their lower portions towards the cut ends. In none of them had the leaves regained their turgescence on the following day. After washing in water for five minutes the parts which had been immersed in eosine were found to be suffused with red, the marginal papillæ were, on the whole, only faintly stained, and in some of the younger leaves hardly stained at all; the upper surfaces of the leaves were fairly evenly stained, in most leaves the under surface was also stained evenly, in others only the marginal portions, which, on the whole, showed more decided staining throughout. Microscopical examination of a strongly stained leaf showed the marginal papillæ very faintly stained, with contents practically colourless, the epidermis along the edge of the leaf with stained contents, other portions of the epidermis stained very little, the vascular bundles strongly stained. In the stem the contents of the epidermis cells and a few of the adjoining cells were slightly stained, the vascular bundles were strongly stained, and the eosine stain had also slightly diffused into the adjoining tissues; the bulk of the cortex, like the bulk of the mesophyll of the leaf, was unstained.

On the whole, the microscopic examination was decidedly in favour of the conclusion that the eosine solution penetrated through the marginal epidermal cells * and not through the papillæ. Thus these papillæ cannot be looked upon as water-absorbing organs unless they behave very differently in other species. Incidentally it was also shown that they cannot be looked upon as water-reservoirs, otherwise the eosine solution would certainly have penetrated into them more freely. However, as the solution which actually entered in twenty-four hours' immersion did not restore the turgidity of the mesophyll-cells it may safely be concluded that the power of taking up water possessed by the leaves (and evidently to a more limited extent by the stem) under experimental conditions is of absolutely no practical consequence to the plant under natural conditions.

This conclusion was strengthened by a further experiment with *Crassula cymosa* arranged after the manner of an old experiment figured by Pfeffer.† A large side-branch of a portion of a plant was immersed in

* Water-stomata, which are found in other species of *Crassula*, seem to be absent here. Most of the stomata all over the leaves were found open, the guard-cells as a rule slightly stained, but the eosine solution had, as a rule, not entered through the stomatal slit.

† W. Pfeffer, "The Physiology of Plants," Engl. Ed., vol. i. (1900), fig. 15, p. 160.

water, while another side-branch, together with the stem bearing them, remained exposed to the air, the cut stem being carefully sealed. Within three days some of the leaves of the branch in air showed signs of becoming flaccid. These signs have increased daily, so that it is clear that the water lost by transpiration of the branch in air cannot be made good by the other branch immersed in water. The same result was obtained with *Crassula multiflora*, Schönl. et Bak. fil., which also possesses marginal papillæ on the leaves.

Summary.—*Mesembrianthemum barbatum* and *Anacampseros filamentosa* cannot absorb any appreciable quantity of water through their aërial organs. *Crassula cymosa* can do so to a small extent, which, however, cannot be of any practical importance under natural conditions. The marginal papillæ of this species are certainly not water-absorbing organs. The experiments throw doubts on the view that many other South African succulents can absorb by means of their aërial organs water of sufficient quantity to make good loss by transpiration.

SOME NEW SOUTH AFRICAN SUCCULENTS. Part II.*

By R. Marloth, Ph.D., M.A., F.R.S.S.Af.

(Plate XXVII.)

(Read June 16, 1909.)

Among the plants, which I am describing in this paper, are a few with a peculiar structure of their leaves. It will be remembered that a year ago † I exhibited a species of *Bulbine*,‡ with window-leaves, pointing out at the time that such a structure has not been observed on any other plant as yet.

The very succulent, nearly egg-shaped leaves of the plant remain embedded in the ground, hence the blunt apex only becomes visible. Here the green tissue is absent, being confined to the sides of the leaf. As the sides are surrounded by soil, the light cannot reach them in the ordinary way, but only by entering through the window at the apex, illuminating the leaf from within.

Since then I have found five other species of plants with such "window-leaves," viz., four species of *Mesembrianthemum*,§ and one species of *Haworthia*.|| They are all stemless succulents with the leaves embedded in the ground, showing only the flat or convex apex, which is entirely devoid of green tissue. Hence, as in the case of the *Bulbine*, the light can reach the green tissue of the leaf only through the window, illuminating the leaf from within. It should be noted, that while in the case of the *Bulbine* there is no epidermis at the window the other five plants have a complete epidermis.

* Part I. appeared in the Transactions of the South African Philosophical Society, vol. xviii., pt. 1, 1907.

† See Rep. of Proc. Roy. Soc. S.A. of meeting held June 17, 1908.

‡ *Bulbine mesembrianthemoides*, Haw. See Plate XXVII., fig. 1.

§ Two of these are described in the present paper, the two others are *M. truncatellum* Haw. and *M. Hookeri*, Berger.

|| This species is the same as that named *Haworthia truncata* by Dr. Schönland in the paper read at the same meeting as the present paper; hence, in order to avoid a synonym, I have cancelled the description and name given by me.

I consider this structure to be principally a contrivance for the protection of the green tissue against the destructive action of too severe sunlight, as explained more fully in another paper.*

GERANIACEÆ.

PELARGONIUM MUNITUM, Burchell, Trav., vol. i., p. 225.

As the specimens on which Burchell founded this species were lost in the parcel which he despatched to Capetown before reaching the Roggeveld, Harvey (Flor. Cap., i., 308) referred the plant to the insufficiently known species. It is therefore advisable to complete the brief description given by Burchell.

Shrubby, thick-stemmed, 2 to 3 feet high, with a few stout branches, covered with the rigid, persistent inflorescences. Leaves bi-pinnatifid, appearing in winter. Flowers in dichotomously branched panicles, each umbel formed of 7 to 9 flowers. Sepals equal, broadly lanceolate with a membranous margin, all reflexed, the tube equal in length to the sepals. Petals subequal, the 2 upper ones very little longer and broader than the others, marked with dark pink stripes near the narrowly eared base; the upper petals 9 mm. long, the others 7 or 8 mm.; stamens 5.

The plant is fairly common on rocky hills of the South-Western Karroo (Prince Albert Road, Laingsburg, eastern side of Hex River Pass), flowering in spring. Marloth, No. 4387. (See figure in Marloth, "Das Kapland," p. 323.)

CRASSULACEÆ.

CRASSULA ALSTÓNII, n. spec. (Sect. *Sphæritis.*)

Planta sterilis globosa, foliis valde carnosis, sub-hemisphæricis, concavis, obtusis, dense aggregatis, squamis setiformibus brevibus, dense obtectis. Inflorescentia longiuscule pedunculata, cymosa, cymis 3- to 5-floratis, glomeratis vel breviter stipitatis. Flores albi, sepalis ovatis, pilosis, petalis liberis, lanceolatis, acutis, conniventibus, apice recurvis, sepalis duplo longioribus. Squamæ sessiles, cuneatæ, apice emarginatæ.

The plant forms globular bodies, in shape somewhat similar to the more widely spread *Crassula columnaris*, but easily distinguished from that plant by the canescent outer surface of the leaves, which is of the

* Ber. Deutsch. Bot. Ges., xxvii., p. 362, 1909.

same nature as in *C. namaquensis*, Schönland et Baker. Leaves about 12 mm. long, 15 mm. broad, and 3 to 5 mm. thick, quite obtuse or with a faintly indicated apex. The erect stout and very short hairs are so closely set that they give the leaf a whitish or grey appearance. Peduncle 2 to 3 inches high, branching above, with 3 to many glomerules. Flowers 3 to 4 mm. in length; petals white with a green or reddish midrib below and a pointed apex, bearing a minute red gland at the back. (Fig. 7.)

Collected near Anenous, in Little Namaqualand, by Mr. Garwood Alston, and flowering in my garden at Capetown in April.

Marloth, No. 4679. Also received by Mr. N. S. Pillans from other parts of Little Namaqualand.

AIZOACEÆ.

Mesembrianthemum opticum, n. spec. (Sect. *Sphæroidea*.)

Planta acaulis, ramosa, pulvinum depressum formans. Corpuscula truncata, glauca, non-punctata sunt, sed facies terminalis margine fauceque albido-marginata est. Ovarium inclusum, compressum; calyx exsertus, sepalis 5, ovalibus, fuscis, hyalino-marginatis. Petala numerosa, roseo-alba, linearia, libera, sepalis duplo longiora. Styli 5, filiformes. Capsula tubiniformis, stipitata, corpuscula haud superans.

Diam. of the cushion-shaped plant 2 to 4 cm., number of corpuscula 4 to 15, each corpusculum 15 mm. long, with a diam. of 10 to 12 mm. at the upper face. Length of sepals 4 mm., of the petals 6 to 8 mm.

The two leaves which form the corpusculum are not joined near the upper end; they are glaucous-green below, but whitish on the terminal, almost flat face, the latter being surrounded by a whitish-brown margin and the whole body encased in a wrinkled, whitish-brown sheath, which is mostly split at one side leaving the truncate end of the leaves quite free.

The flowers open only in bright sunlight, the petals are pure white or tinged with pink; the small ovary and its very succulent stalk are compressed and almost 2-edged; the styles greenish, the filaments white, the anthers yellow. (Fig. 5.)

Growing in sand-covered fissures of gneiss-rocks near Prince of Wales Bay, in Great Namaqualand, flowering April, 1909. Altitude 50 m. Marloth, 4675.

This is one of the few plants which possess leaves with an apical window, through which the light enters, illuminating the green tissue from within. The plants are almost buried in the sand, the apex only

of the leaves being visible. In this portion, viz., at the apex, the leaf possesses no chlorophyll, hence the water-storing tissue is here in direct contact with the epidermis, thus being able to diffuse the light that enters through the window, before it reaches the green tissue.

Mesembrianthemum fimbriatum Sond. (See Sonder in Flor. Cap., ii., p. 393.) (Amended description.)

Calyx tubular, membranous, the segments oval, membranous, the edges transparent; petals 15 to 20, connate into a membranous tube, the free limb linear, slightly exceeding the sepals, white or cream-coloured; stamens, incl. of the yellow, linear anthers, about as long as the sepals. Styles 6, yellow, filiform, longer than the petals. Diam. of corpusculum 3 to 4 mm., exserted part of flower (in wild plants) 3 mm. long. The corpuscula are closely pressed against each other, forming hemisphærical, cushion-shaped lumps, 1 to 3 inches in diam.; grey or whitish in appearance, as the dry sheaths only are visible.

The plant lives in the fissures of the bare rocks in the coastbelt of Great and Little Namaqualand and is able to do without rain, as the spongy sheaths and the hairs, which fringe the fissure of the corpusculum, absorb sufficient water from dew and mist, both yielding an ample supply in those regions. The root-system of each lump is only small. Flowering near Angra Pequena in May, 1909. Marloth, No. 4674.

Mesembrianthemum rhopalophyllum, Schlechter et Diels. (Schultze, Aus Namaland und Kalahari, p. 692.)

The original diagnosis of this species was made from sterile specimens. As plants found by me at the same locality as the original specimens, viz., in the neighbourhood of the Prince of Wales Bay, in Great Namaqualand, have now flowered in my garden, I am able to add the following description of the flowers:—

Flores solitarii, penduncculis basi bibracteatis folia superantibus. Sepala 5, ovata, olivacea, membranaceo-marginata. Petala pluriseriata, lineari-lanceolata. Styli 5, fimbriati.

Pedicel about 1 inch long, provided with 2 small, connate, succulent bracts at its base. Flowers pure white or tinged with pink; petals 12–14 mm., spreading in the sun. Styles short, fimbriate, especially at their inner side.

The leaves of this plant are embedded in the sandy soil like those of *Mes. marginatum*, described in this paper, and they possess a similarly constructed apical window through which they receive their light. Marloth, No. 4681.

MESEMBRIANTHEMUM DIGITIFORME, Thunb.

Planta subacaulis, radice lignosa, foliis oppositis, inæqualibus, basi in corpusculo cylindrico connatis, apicem versus liberis, valde cylindricis, rotundatis. Flores sublaterales, sessiles, solitarii, parvi, albi, ovario incluso.

A number of stout branches arise from a common, stout, woody root, forming a lump as big as a fist or a small head. Each branch consists only of one pair of leaves, which form a fleshy corpusculum, somewhat like those of the section *Sphæroidea*, but of a different structure. The greater portion of this body is formed by one leaf, which sheathes round the smaller one, thus forming a cylindrical fleshy mass, 1 to 1½ inches in length and ¾ inch in diam., which is terminated by the ends of the two leaves; the free end of the smaller one is ½ inch long, the other one 1 inch long and ½ to ¾ inch in diam., the apex of both being rounded. The flower appears at the junction of the two leaves, the ovary remaining enclosed, the petals being very stiff, white, lasting two weeks or longer. Diam. of flower 8 to 10 mm.

The corpusculum is surrounded by numerous sheaths, the remains of former generations of leaves, the youngest generally reaching as far as the junction of the leaves. The leaves are soft and juicy, bright green, with a thin skin. Owing to the large amount of watery sap contained in the leaves they are readily eaten by the stock in times of drought, otherwise not touched owing to their saline taste. (Fig. 3.)

Found on a stony plain near Van Rhynsdorp by Mr. W. Spilhaus. Flowering in my garden at Capetown in December, 1906. Marloth, No. 4677.

MESEMBRIANTHEMUM CINEREUM, n. spec. (Sect. *Subquadrifolia.*)

Planta acaulis. Folia 4–6, dense aggregata, hemisphærice-triquetra, superne plana, apice obtusissima, papillis erectis, piliformibus, brevissimis dense obtecta et cinerea. Flores solitarii, inter folia superiora sessiles; sepala 5, valde inæqualia, tria carnosa foliis similia, duo minora membranacea; petala linearia, rigida, uni-seriata, recurva, alba, nitida. Stamina alba antheris flavis. Capsula subsessilis.

Stemless or nearly so, often several short branches from a woody root, forming a compact lump, 5 to 20 cm. in diam. The leaves are very closely pressed against each other, flat above, thicker than broad when young, but of the shape of half a chestnut when fully grown, with a blunt carinal angle. The surface of the leaves is grey or whitish, owing to its being densely covered with short and minute papillæ of a similar structure as found in several species of *Crassula.*

Length of leaves 20 to 25 mm.; width and thickness 14 to 18 mm.; diam. of flower 20 mm. The sepals hardly project above the upper pair of leaves, the petals are glossy white, 10 to 12 mm. long, curving back and remaining spread out night and day. Diam. of capsule 8 mm. (Fig. 2.)

Growing on cliffs of grey-coloured limestone a few miles east of Prince of Wales Bay in Great Namaqualand at an alt. of 50 to 100 m. Flowering in June. Marloth, No. 4680.

EUPHORBIACEÆ.

EUPHORBIA BASUTICA, n. spec. (Sect. *Medusea.*)

Planta humilis, paullo ramosa, non rosulata, podariis rhomboideis, obtuse-pyramidalibus. Folia brevissima, lineari-ovalia, concava, decidua. Cyathia in apicibus ramorum sessilia, foliolis 3–4 ovato-cuneatis, ciliatis suffulta. Involucrum campanulatum lobis latissimis, brevissimis, truncatis, denticulatis, viridibus; glandulis sub-stipitatis, transverse-ovalibus, concavis, punctatis, sub-viridibus, in 4–5 lacinias breves partitis; styli breves, involucro haud superantes, stigmatibus crassis, ovalibus.

This plant agrees exactly with the figure on plate 150 of De Candolle's Plantes Grasses, but is certainly not a form of *E. caput medusæ*—a plant occurring frequently in the neighbourhood of Capetown. Berger in "Sukkulente Euphorbien," p. 113, identifies De Candolle's figure with *E. parvimamma*, Boissier (ex Prodromus, xv., 2, p. 86), but his own figure of the supposed *E. parvimamma* shows the segments of the involucre to be triangularly pointed and well fimbriated, while DC.'s figure in Pl. Gr. and our plant possess very broad, retuse and finely denticulate segments. (Fig. 6; magnified 2x.)

Berger's plant may be *E. parvimamma*, Boiss., which was named from sterile specimens only, or not; that does not concern us here, but it is certainly different from the figure in Plantes Grasses. As the latter agrees so well with our plant, it became necessary to name the latter.

Syn.: *E. caput medusæ*, L., var. *minor*, DC. in Plantes Grasses, tab. 150.

The plant (2 specimens) was sent by Mrs. A. Dieterlen, from Leribe, in Basutoland, and flowered in Mr. E. P. Phillips' cultures at the Government Herbarium, Capetown, in February, 1909.

LILIACEÆ.

ALOE KRAPOHLIANA, n. spec. (Sect. *Acaules.*)

Acaulis. Folia numerosa, anguste-lanceolata, acuminata, supra subtusque convexa, apice incurvata, glauca, margine dense et minute den-

ticulata. Racemi 1–3, ex centro foliorum, robusti, simplices, bracteis ovato-acuminatis; floribus longe pedicellatis, nutantibus. Perianthium cylindricum, utrinque paullo attenuatum; segmenta exteriora libera vel basi haud connata, apicibus erectis; interiora paullo longiora, apicibus recurvis, faucem apertam, rotundam formantibus; stamina stylusque demum breviter exserta.

Diam. of rosette of leaves 15–20 cm.; leaves 20–30, each 6–10 cm. long, at the base 12–15 mm. broad, and half as thick, with a convex upper and lower face, curving upwards from the middle. Teeth very numerous, small, white, 1–2 mm. long, mostly straight or occasionally incurved towards the apex of the leaf. Peduncle stout, the bare portion 6–12 inches long with a few broader bracts; the floriferous part finally 6–10 inches long, with acuminate bracts, which are green with purple margins, or, especially lower down, quite purple. Flowers brick-red, the outer segments with a green midrib near the blunt apex, the inner segments pale greenish with a deep-green, oblong apex. Anthers orange, finally exserted.

Described from plants collected near Pella, in Little Namaqualand, by Mr. J. H. C. Krapohl, and flowering in my garden at Capetown in May, 1909. Marloth, 4673.

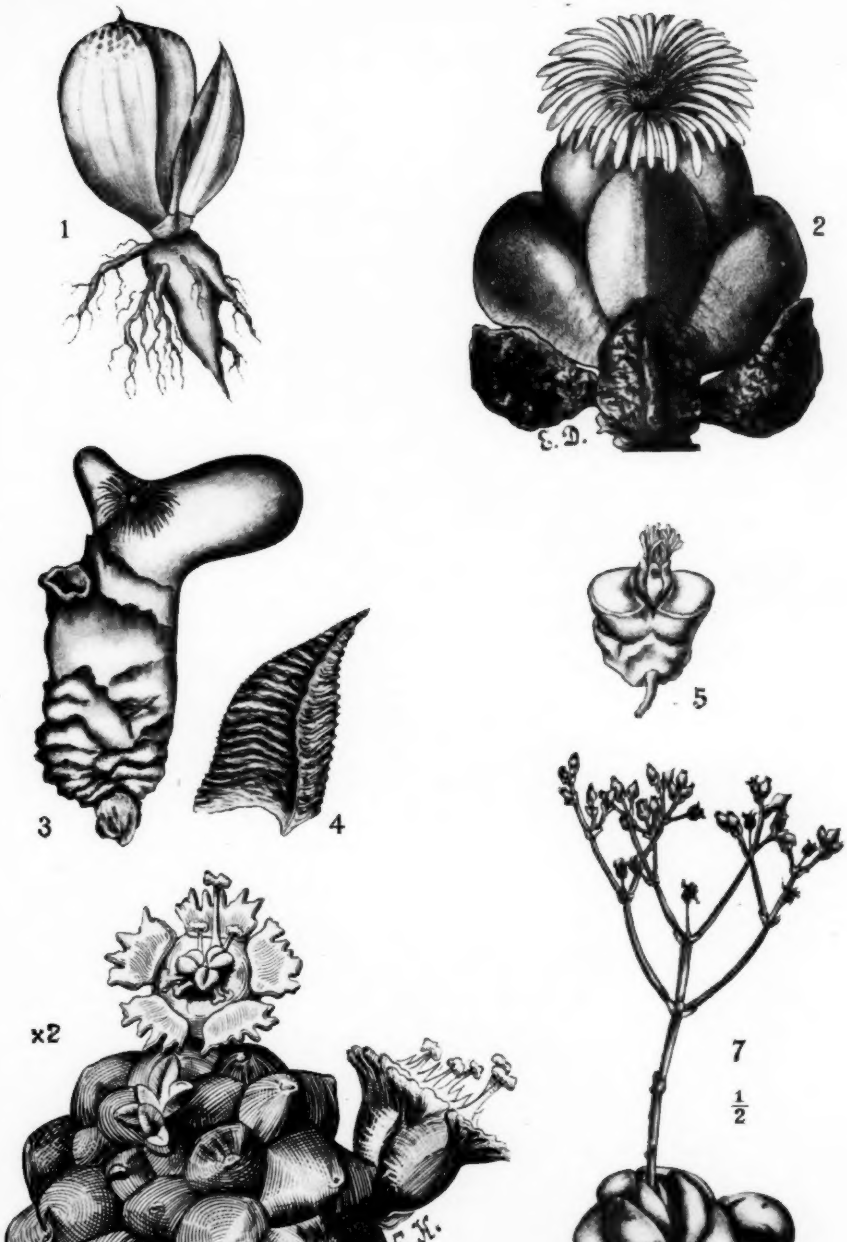
HAWORTHIA LIMIFOLIA, n. spec. (Sect. *Margaritifera.*)

Acaulis. Folia dense rosulata, ovato-lanceolata, acuminata, supra concava, obscure-viridia, non-tuberculata sed supra subtusque numerosis (15–20) lineis elevatis, undulatis transverse striata.

Diam. of rosette of leaves 6–8 cm.; leaf 3–4 cm. long and 18–20 mm. broad at its base; peduncle 20–30 cm. high, raceme 5–8 cm. long; perianth slightly 2-lipped, the tube slightly inflated below, green, 10–12 mm. long, the recurved segments 5–6 mm. long, with a touch of pink and a green midrib.

The surface-markings of the leaves are quite different from those of any other species, and might be sufficient to constitute a new section, viz., *Limifolia*, on account of the similarity of the surface to that of a coarse file.

The plants were received from Mr. Medley Wood, director of the Botanic Gardens at Durban, who obtained them originally from the country West of Delagoa Bay. Flowering at Capetown, in December, 1908. Marloth, No. 4678.



West, Newman proc.

1. Bulbine mesembrianthemoides, *Haw.* 2. Mesembrianthemum cinereum, *Marl.* 3. M. digitiforme, *Thunb.* 4. Haworthia limifolia (a leaf), *Marl.* 5. Mesembrianthemum opticum, *Marl.* 6. Euphorbia basutica, *Marl.* 7. Crassula Alstonii, *Marl.*

NOTE ON AN ABNORMAL SEEDLING OF *WIDDRINGTONIA CUPRESSOIDES*, AND A BRIEF ACCOUNT OF THE VASCULAR SYSTEM OF THE NORMAL SEEDLING.

By H. S. Morris. Communicated by E. P. Phillips, M.A.

(Read June 16, 1909.)

Among some seedlings of *Widdringtonia cupressoides*, Endl.,* kindly germinated by Mr. G. H. Ridley, of the Municipal Gardens, Cape Town, for Mr. W. T. Saxton, of the South African College, who handed them over to me for investigation, was a curious example of incomplete twin formation. As far as the writer is aware, there is no other case on record of such an occurrence among Gymnosperms, although somewhat similar cases have been found among Dicotyledons.

This specimen (shown in Fig. 1) consisted of two seedlings fused together very completely throughout the length of the hypocotyl and the upper part of the root. The two root-tips were, however, separate and distinct, as were the two pairs of cotyledons and the plumules. In the fused part the cortical tissue of the two seedlings was continuous, and had a com-

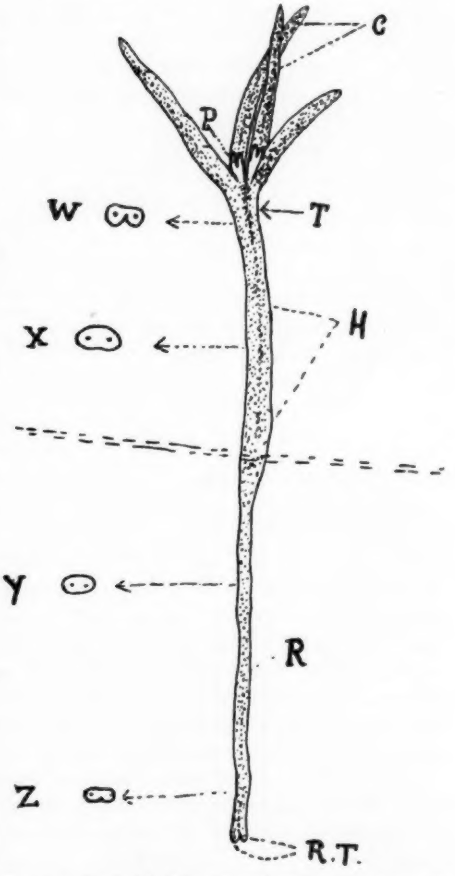


Fig. 1.—C = cotyledons; P = plumule; T = transition region; H = hypocotyl; R = root; RT = the two root-tips; W, X, Y, Z = successive transverse sections through regions indicated by arrows. (Natural size.)

* = *Callitris cupressoides*, Vent.

mon epidermis. The two must therefore have been united from a very early period of development. As the two plants were so intimately bound together they probably arose from the same archegonium; each, possibly, from one of the two daughter nuclei resulting from the first division of the oospore.

Although the epidermis and the cortex were continuous, yet the vascular systems of the two halves were completely separate, as shown in Fig. 2. There was no difference between the vascular structure of the two parts, and each resembled exactly that of a normal seedling. Each part of the root showed the usual diarch structure, and the transition from stem to root structure was very rapid, taking place just below the insertion of the seed leaves.

In this seedling, and in two normal ones studied, the transition phenomena were different from those described for *Widdringtonia mahoni*, Mast., and *W. whytei*, Rendle, by Hill and de Fraine.* In *Widdringtonia cupressoides* the single bundle of the cotyledon was still entirely undivided when it reached the central cylinder of the hypocotyl. In this region the phloem forms a continuous ring, and the xylem of the seed-leaf traces becomes mesarch and finally exarch. When the latter condition obtains the phloem disappears opposite the two protoxylem groups, thus resulting in the typical diarch root.

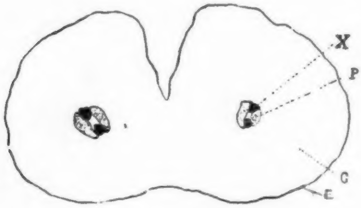


Fig. 2.—X = xylem; P = phloem; C = cortex; E = epidermis. The position of this section is shown by W in Fig. 1. (× 22.)

The splitting of the seed-leaf trace described by Hill and de Fraine (*loc. cit.*) for the two species mentioned above does not take place, nor does the transition from the hypocotyl to root in this species correspond exactly to that in any member of the Cupressineæ as described by these authors, more nearly approaching that in *Cephalotaxus pedunculata*, Sieb. and Zucc. This indicates a greater simplicity of structure in *W. cupressoides* than in the above-mentioned species.

In conclusion, I may state that these investigations were carried out in the Botanical Laboratory of the South African College, Cape Town, under the supervision of Mr. W. T. Saxton, M.A., to whom I wish to express my thanks.

* T. G. Hill and E. de Fraine (1908), "On the Seedling Structure of Gymnosperms," I. *Ann. Bot.* xxii., 88, 1908.

THE GENESIS OF THE CHEMICAL ELEMENTS.

By James Moir, D.Sc., M.A., F.R.S.S.Af.

(Read July 21, 1909.)

The author has discovered a new and remarkable relationship between the atomic weights, whereby the accepted values can be calculated with remarkable accuracy. The assumptions required are: (1) a *proton* ($\overline{H}$) consisting of $\frac{111}{112}$ of the atom of hydrogen, (2) another (μ) consisting of $\frac{1}{112}$ of the atom of hydrogen, and (3) another (ω) consisting of $\frac{1}{10}$ of the hydrogen atom; also that valency depends on the number of times the *proton* μ occurs in the element in question.

All the elements are multiples of $\overline{H}$ plus the required and regularly varying number of the *proton* μ; but some contain, in addition, an erratic number of the *proton* ω. The following Table gives the results; and the last column gives the experimental atomic weights reduced to the same basis.

Symbol.	Natural Formula.	Formula in Figures ($\overline{H} = 1$)	Experimental Atomic Weight (O = 16·018)
H	$\overline{H} + \mu$	1·00901	1·0090
He	$4\overline{H}$	4·00	4·004
Li	$7\overline{H} + \mu$	7·009	7·008
Gl	$9\overline{H} + 2\mu + \omega$	9·118	9·120
B	$11\overline{H} + 3\mu$	11·027	11·012
C	$12\overline{H} + 4\mu$	12·036	12·034
N	$14\overline{H} + 3\mu$	14·027	14·023
O	$16\overline{H} + 2\mu$	16·018	16·018
F	$19\overline{H} + \mu$	19·009	19·021
Ne	$20\overline{H}$	20·00	20·02
Na	$23\overline{H} + \mu$	23·009	23·025
Mg	$24\overline{H} + 2\mu + 3\omega$	24·318	24·347
Al	$27\overline{H} + 3\mu + \omega$	27·127	27·130
Si	$28\overline{H} + 4\mu + 3\omega$	28·336	28·332
P	$31\overline{H} + 3\mu$	31·027	31·034

Symbol.	Natural Formula.	Formula in Figures ($\bar{H} = 1$).	Experimental Atomic Weight (O = 16·018).
S	$32\bar{H} + 2\mu + \omega$	32·118	32·105
Cl	$35\bar{H} + \mu + 5\omega$	35·509	35·500
A	$40\bar{H}$	40·00	40·045
K	$39\bar{H} + \mu + \omega$	39·109	39·138
Ca	$40\bar{H} + 2\mu + \omega$	40·118	40·134
Sc	$44\bar{H} + 3\mu + \omega$	44·127	44·150
Ti	$48\bar{H} + 4\mu + \omega$	48·136	48·154
V	$51\bar{H} + 5\mu + 2\omega$	51·245	51·257
Cr	$52\bar{H} + 6\mu + \omega$	52·154	52·158
Mn	$55\bar{H} + 2\mu$	55·018	54·992
Fe	$55\bar{H} + 2\mu + 9\omega$	55·918	55·913
Ni	$58\bar{H} + 2\mu + 7\omega$	58·718	58·745
Co	$59\bar{H} + 2\mu$	59·018	59·066
Cu	$63\bar{H} + 2\mu + 6\omega$	63·618	63·641
Zn	$65\bar{H} + 2\mu + 4\omega$	65·418	65 443
Ga	$70\bar{H} + 3\mu$	70·027	69·98
Ge	$72\bar{H} + 4\mu + 5\omega$	72·536	72·58
As	$75\bar{H} + 3\mu$	75·027	75·084
Se	$79\bar{H} + 2\mu + 3\omega$	79·318	79·289
Br	$80\bar{H} + \mu$	80·009	80·010
Kr	$83\bar{H}$	83·00	83·09
Rb	$85\bar{H} + \mu + 5\omega$	85·509	85·545
Sr	$87\bar{H} + 2\mu + 7\omega$	87·718	87·718
Y	$89\bar{H} + 3\mu$	89·027	89·099
Zr	$90\bar{H} + 4\mu + 6\omega$	90·636	90·702
Cb	$93\bar{H} + 5\mu + 6\omega$	93·645	93·605
Mo	$96\bar{H} + 6\mu$	96·054	96·108
Ru	$101\bar{H} + 8\mu + 8\omega$	101·872	101·82
Rh	$103\bar{H} + 8\mu$	103·072	103·02
Pd	$106\bar{H} + 2\mu + 8\omega$	106·818	106·820
Ag	$108\bar{H} + \mu$	108·009	108 002
Cd	$112\bar{H} + 2\mu + 5\omega$	112·518	112·526
In	$115\bar{H} + 3\mu$	115·027	114·93
Sn	$119\bar{H} + 4\mu + \omega$	119·136	119·135
Sb	$120\bar{H} + 3\mu + 3\omega$	120·327	120·336
Te	$127\bar{H} + 2\mu + 6\omega$	127·618	127·644
I	$127\bar{H} + \mu$	127·009	127·063
X	$130\bar{H}$	130·00	130·15
Cs	$133\bar{H} + \mu$	133·009	132·96

Symbol.	Natural Formula.	Formula in Figures ($\bar{H} = 1$).	Experimental Atomic Weight ($O = 16{\cdot}018$).
Ba	$137\bar{H} + 2\mu + 5\omega$	137·518	137·524
La	$139\bar{H} + 3\mu + \omega$	139·127	139·16
Ce	$140\bar{H} + 4\mu + 3\omega$	140·336	140·408
Pr to Yb	All $n\bar{H} + 3\mu$	— —	— —
Ta	$181\bar{H} + 5\mu + \omega$	181·145	181·205
W	$184\bar{H} + 6\mu + \omega$	184·154	184·208
Os	$191\bar{H} + 8\mu$	191·072	191·10
Ir	$193\bar{H} + 8\mu + 3\omega$	193·372	193·32
Pt	$195\bar{H} + 4\mu + 2\omega$	195·236	195·221
Au	$197\bar{H} + 3\mu + 4\omega$	197·427	197·423
Hg	$200\bar{H} + 2\mu + 2\omega$	200·218	200·226
Tl	$204\bar{H} + \mu + 2\omega$	204·209	204·23
Pb	$207\bar{H} + 2\mu + 3\omega$	207·318	207·33
Bi	$208\bar{H} + 3\mu + 3\omega$	208·327	208·235
Ra	$226\bar{H} + 2\mu$	?226·018	226·6
Th	$233\bar{H} + 4\mu$	?233·036	232·68
U	$239\bar{H} + 6\mu$	?239·054	238·77

It will be seen that the new scheme brings out closer relationships between such groups as the alkali-metals and the halogens; and that, although it follows the Periodic Law, it would require the latter to be modified in important particulars, *e.g.*, from platinum to bismuth.

The author thinks it not impossible that in certain reactions, where the valency increases, one or more protons μ go amissing despite the "conservation of mass." Thus the components of NH_4Cl contain 8μ, whereas NH_4Cl probably only contains 6μ.

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EVAPORATION IN A CURRENT OF AIR.

(Part I.)

By J. R. Sutton, M.A., Sc.D., F.R.S.S.Af., Hon. Memb. R. Met. S.

(Read July 21, 1909.)

The results of the observations upon the rate of evaporation made under natural conditions at Kenilworth (Kimberley) with gauges of various patterns have always shown a provoking disinclination to conform to Fitzgerald's formula—

$$E = \{A(T - t) + B(T - t)^2\}(I + CW)^{\frac{1}{3}}),$$

not only when monthly averages of evaporation, temperature, and wind-movement are considered, but also (and particularly) for short intervals of time. By "natural conditions" is meant the ordinary meteorological conditions of observation—as distinguished from the artificial conditions of the laboratory—the water being heated by radiation from the sun or by conduction from the air. Only in the roughest way do the quantities of water evaporated in this way vary as the difference between the vapour pressures at the temperatures of the water and the dew-point, represented by the quantity $T - t$ in the formula. Instead they suggest rather that the temperature of the air has first to be taken into account; that is, that the relative humidity of the air is of more importance than the absolute humidity. Nor does the evaporation at Kenilworth correspond so simply to the movement of the wind as it seems to do at Boston, U.S.A., where Fitzgerald's observations were made.

The main obstacle in the way of discovering the true law of evaporation is, of course, the difficulty of separating one determining factor from another. Consequently it has been the custom to deduce a "law" from theoretical considerations, and to determine the numerical values of the terms in the mathematical expression of the "law" from observational averages. But the various evaporation factors are so indissolubly inter-

woven that this way of determining the value of the respective terms representing them in the mathematical expression of the so-called law is likely to lead to error. At Camden Square, London, for example, "the curve of wind-velocity appears to have very little relation to that of evaporation."* At Kenilworth the curve of the monthly quantities of evaporation throughout the year follows closely the curve of the monthly wind movement. But this agreement is quite illusory, for it so happens that the air is dry on the whole in the more windy spring months, and relatively damp in the quiet autumn. On the other hand, if we compare one day with another, we find that there is no correspondence between the variations of evaporation and those of wind velocity. Here it is the disagreement that is illusory, because an excess of wind-movement generally means an increase of the moisture content of the air: one therefore neutralising the other.†

It is with the object of getting a better idea of the value of the wind factor in evaporation that the experiments described in this paper were begun. They differ from my previous experiments in being made under artificial conditions—*i.e.*, inside a room instead of in the open air, and in an artificial current of air generated by an electric fan instead of in the wind; they agree with my former experiments only in so far as they show the extreme difficulty of handling the determining phenomena of evaporating water and water vapour. The method of the experiments was to place four silver-plated cups nearly full of water at different distances from an electric fan, the plane of rotation of the fan being at right angles to the line joining the cups. The cups were the same as those used in measuring the evaporation at the bottom of iron pipes of different lengths,‡ their dimensions being approximately $2\frac{1}{2}$ inches deep inside, about $2\frac{3}{8}$ inches diameter near the bottom, and about $2\frac{1}{2}$ inches diameter near the top, their convenient working capacity being about 2,250 grains of water. The temperature of the water in each cup was noted at the beginning and at the end of each experiment, as well as the temperature and moisture of the air of the room, and the velocity of the air current as it passed over each cup—this last being measured by means of a Davis air meter, reading in feet, placed for half a minute immediately in front of a given cup. The duration of each experiment was 50 minutes. The cups were numbered for purpose of identification, and placed in a different order each day with the idea of eliminating what may be called any personal equation on the part of a cup.

* Mill, *British Rainfall* for 1907.

† Sutton, "Results of some Experiments upon the Rate of Evaporation," *Trans. S.A. Phil. Soc.*, vol. xiv., 1903.

‡ Sutton, "A Contribution to the Study of Evaporation from Water-surfaces," *Proc. R. Dublin Soc.*, February, 1907.

In the first few trials the gauges were placed opposite the lower edge of the fan, the wind velocity being measured opposite the centre of the fan. The following are two typical results :—

Dry bulb	82·0°	73·6°
Dew-point	33·4	34·8
Humidity, per cent.	17	24
Current velocity 14 inches from fan in feet per min.	953	976
,, ,, 30 ,, ,,	750	734
,, ,, 46 ,, ,,	451	584
Final temperature of water 16 inches from fan	72·0°	67·0°
,, ,, 32 ,,	71·8	66·1
,, ,, 48 ,,	71·9	66·1
Loss by evaporation 16 inches from fan	56·8 gr.	46·4 gr.
,, 32 ,,	76·0	56·8
,, 48 ,,	69·6	54·4

Since the loss is greater at a distance of 32—and even at 48 inches—than it is at 16 inches, it is quite clear that the effective strength of the air current cannot be as great at the lesser distance as it is at the greater ones. This was proved by the following observations :—

Dry bulb	81·0°
Dew-point	40·5
Humidity, per cent.	24
Final temperature of water in still air	79·5
,, ,, 12 inches from fan	73·0
,, ,, 24 ,,	73·0
,, ,, 36 ,,	72·5
,, ,, 48 ,,	73·0
Loss by evaporation in still air	12·8 gr.
,, 12 inches from fan	48·8
,, 24 ,,	56·8
,, 36 ,,	59·2
,, 48 ,,	57·6

In this instance the water-level was opposite the lower edge of the fan, as before. When the anemometer was level with the water its indications were—

10	inches from fan	132	feet per minute
22	,,	380	,,
34	,,	522	,,
46	,,	424	,,

When it was raised to a line opposite the centre of the fan—

10 inches from fan	890 feet per minute
22	,,	876	,,
34	,,	760	,,
46	,,	512	,,

Evidently, therefore, the current of air thrown out by the fan is not a simple cylinder in shape, but spreads out, say, conewise from some point in the axis, or axis produced, of the fan. Hence it comes about that the loss by evaporation is so much less in the comparatively sheltered position of the cup nearest the fan.

In further experiments the gauges were placed upon a shelf, the fan being placed upon a box beyond the end of the shelf at such a height that its axis was about 3 inches higher than the water-level of the gauges. By this arrangement the lower edge of the fan was slightly below the edge of the shelf. For the purpose of reading the velocity of the current of air the anemometer was placed with its axis nearly level with the water. The first set of experiments under these conditions gave the following mean results:—

Current velocity	7 inches from fan		1,054 feet per minute	
,,	21	,,	866	,,
,,	35	,,	694	,,
,,	49	,,	539	,,

the average of the temperatures of the water at first being 79·9°. And by dividing the separate experiments into two sets, according as the relative humidity of the air of the room was greater or less than the mean of all, we get the following:—

Dry bulb	80·7°	78·3°
Dew-point	33·9	40·7
Humidity, per cent.	18·5	26·3
Final temperature of water in still air	76·4	75·9°
,, ,, 9 inches from fan	70·4	70·4
,, ,, 23 ,,	70·3	70·3
,, ,, 37 ,,	71·0	70·7
,, ,, 51 ,,	70·9	70·8
Loss by evaporation in still air	17·3 gr.	16·0 gr.
,, 9 inches from fan	110·7	84·5
,, 23 ,,	110·7	84·2
,, 37 ,,	91·8	73·3
,, 51 ,,	77·1	61·8

The last set of experiments gave the following mean results:—

Dry bulb	79·1°
Dew-point	46·2
Humidity, per cent.	34
Current velocity 4 inches from fan	1,043 ft.
„ 13 „	872
„ 22 „	766
„ 31 „	651
Initial temperature of water	79·8°
Final temperature of water in still air	75·7
„ „ 6 inches from fan	71·7
„ „ 15 „	71·1
„ „ 24 „	71·4
„ „ 33 „	71·4
Loss by evaporation in still air	16·0 gr.
„ 6 inches from fan	82·3
„ 15 „	85·8
„ 24 „	79·7
„ 33 „	72·7
Difference between the vapour pressures at the temperature of the water 6 inches from the fan and the dew-point	0·46 in.

Since the loss at a distance of 15 inches is even here greater than at 6 inches, it is plain that the effective strength of the air current is again less at the nearer distance. No way that I have been able to devise, however, shows with any certainty that the direct current from the fan moves more slowly over the nearer surface than over the more remote. The explanation seems to be partly that the air current is not flowing in straight lines, but has a tumbling motion, by means of which subsidiary cross-currents, which have no effect on the anemometer, interfere more with the water 15 inches away than with the water 6 inches away. Moreover, the anemometer necessarily integrates the whole of the direct current crossing the plane commanded by its vanes: it by no means follows that the velocity indicated by the anemometer is the velocity of that part of the air current that strikes the axis of the anemometer. This point remains for further investigation.

The surface of the water in the gauges always becomes a good deal agitated by the strong draught, and in a way that certainly suggests the presence of cross-currents rather than a simple direct flow of air; and besides, the water circulates with considerable speed round the vertical axis of the mass of water. This agitation, conjoined with the near approach to equality in the temperatures of the water surfaces in the

different gauges at their different respective distances, raises three points for consideration in the framing of a correct evaporation theory. First, that however favourable we may try to make the conditions, the rate of evaporation from a *given* surface area cannot be made indefinitely rapid.[*] If this be so it follows that when the maximum rate of evaporation from the given surface is reached, any further increase of wind velocity is of no effect, because there is no additional quantity of water vapour to be carried away. The wind factor in Fitzgerald's formula can therefore at the best only apply at velocities below a certain fixed upper limit. Second, and arising directly out of the first, if the rate of evaporation can be accelerated from a given mass of water by every increase of wind velocity, it can only be because the increased agitation of the water increases the area of the evaporating surface, and not that the evaporation from a given surface is affected at all. Now the wet bulb assumes its lowest temperature in a comparatively weak draught,[†] so that it seems a fair inference that the evaporation from an undisturbed water surface reaches its maximum rate on account of the wind alone, also in a comparatively weak draught. For that reason it is not very likely that much success will attend the proposal to determine the moisture in the air from the measured rate of evaporation from a water surface.[‡] Third, that the agitation of the water mixes the cool evaporating surface with the warmer lower layers more effectually than would be the case if the cool surface particles had to sink by their own gravity. This factor reduces the effective temperature of the surface of a small mass of water much more quickly than it does a large mass.

Leaving out of account the small differences in the final temperature of the water in the different gauges, the loss by evaporation in the gauges at 15, 24, and 33 inches is closely represented by the formula—

$$E = \frac{3}{2}(W^{\frac{1}{2}} - 2{\cdot}8)$$

where E is the loss of water in grains, and W the velocity of the air current in feet per minute.

In the large Table at the end will be found details of the last series of experiments arranged in order of relative humidity, to which is added, for

* It has been stated that the evaporation from water *in vacuo* is instantaneous. But Hertz, in describing one of his experimental researches, has pointed out that the existence of a limited rate of evaporation for every fluid is demanded by the kinetic theory of gases. In air, of course, the rate will be much slower than in a vacuum.

† Unless the depression of the wet bulb be very great. See Sutton, "A Comparison between Glaisher's Factors and Ferrel's Psychrometric Formula," *Quarterly Journal, R. Met. S.*, January, 1906.

‡ On this point, however, see Cleveland Abbe's "Treatise on Meteorological Apparatus and Methods," 1888.

comparison, the difference of temperature between the water in the gauge 6 inches from the fan and the dew-point, and also the difference of vapour pressure at the temperatures of the water in the same gauge and the temperature of the dew-point. The loss evidently decreases as the relative humidity increases, and fairly regularly. Such variations as there are in the regularity must be attributed to occasional variations in the strength of the wind current during the 50 minutes of observation. A curious relation, for which I see no obvious physical reason, is shown by the sequences of evaporation and of temperature differences. Calling the final temperature of the water τ, and the temperature of the dew-point θ, the formula—

$$E = A(\tau - \theta)$$

is approximately true, E being the evaporation in grains, as before, and A a constant depending on the distance of the gauge from the fan. For a distance of 6 inches A is 3·2 very nearly.

One point must not be lost sight of in judging the results given in this paper, and that is that some time elapsed in each case before the water, falling from its initial temperature, attained its final stationary temperature. It is not easy to measure the simultaneous rate of fall of the temperature of the water in a number of gauges in a strong draught; but the following comparison between two of them will help to some extent:—

Interval.	15 inches from Fan.		33 inches from Fan.	
0 minutes	77·0°	Rate	77·0°	Rate
5 "	70·1	6·9°	71·0	6·0°
10 "	66·1	4·0	68·0	3·0
15 "	63·9	2·2	65·2	2·8
20 "	62·0	1·9	64·0	1·2
25 "	61·0	1·0	63·0	1·0
30 "	60·2	0·8	62·0	1·0
35 "	60·0	0·2	61·6	0·4
40 "	59·8	0·2	61·0	0·6
45 "	59·6	0·2	61·0	0·0
50 "	59·1	0·5	60·9	0·1
55 "	59·2	− 0·1	60·9	0·0
60 "	59·4	− 0·2	61·0	−0·1

Air current at 13 inches from fan 1,004 feet per minute, and at 33 inches from fan 736 feet per minute.

Dry bulb	65·0°
Dew-point	38·1
Humidity, per cent.	37

From this it will be seen that it takes 40 minutes for the gauge at 33 inches to fall 16 degrees, and only 25 minutes for the gauge at 15 inches. The nearer gauge, however, continues to fall for fully 50 minutes, and reaches a lower temperature than the final stationary temperature of the farther gauge. The results in this case are fairly representative, and will no doubt suffice to give a general idea of what goes in.

It would have been much more interesting if each of the experiments noted in this paper could have been continued for another 50 minutes, the first 50 in a falling temperature, and the second after the stationary temperature was reached. Unfortunately, however, I was only able to get the use of the fan for an hour each day, with one or two exceptions; and consequently could not do this desirable thing. I hope, however, before long, to commence a series of similar experiments in which the water at first shall be cold instead of warm. Meanwhile, here are the results in a case in which the water was cooled nearly to its final temperature before commencing the experiment:—

Dry bulb	63·0°
Dew-point	38·1
Humidity, per cent	40
Current velocity, 13 inches from fan per minute	1,004 ft.
" " 31 " "	725 "
Initial temperature of water	58·8°
Final temperature of water 15 inches from fan	58·2
" " 33 "	58·9
Loss by evaporation 15 inches from fan	55·2 gr.
" 33 "	42·4

Nothing in the large Table at the end is very suitable for comparison with this. Perhaps the eighth line from the bottom is the best to take. The comparative results for, the gauges at 15 inches from the fan are:—

Dry bulb	58·8°	63·0°
Vapour pressure at temperature of dew-point	0·216 inch	0·230 inch
" " final temperature of water	0·418 "	0·436 "
Humidity, per cent	44	40
Current velocity per minute	872 feet	1,004 feet
Initial temperature of water	69·2°	58·8°
Loss by evaporation	53·6 gr.	55·2 gr.

In each case the vapour-pressure difference is nearly the same, *i.e.*, 0·202 inch in the one case, and 0·206 in the other, while the relative

humidities are not greatly different. If the velocity of the air current were alone in question, we should have expected that the second column would have contained a loss of some $3\frac{1}{2}$ grains greater than the first column. Since it is considerably less than this—only 1·6 grains—the inference to be considered is that vapour is passing off from the water surface more rapidly at first when warm water is used than when the stationary temperature is attained. This is what would have been expected.

The following values are derived from an experiment—the only one I have as yet been able to make—upon the comparative, simultaneous rate of evaporation from warm water and from water first cooled to its final temperature. Four gauges were used in pairs, one gauge with warm and one with cold water, placed side by side at a distance of 15 inches from the fan; one with warm and one with cold water at a distance of 33 inches.

Dry bulb	64·0°
Dew-point	42·0
Humidity, per cent.	45
Current velocity, 13 inches from fan per minute	884 ft.
„ „ 31 „ „	668 „

	15 inches from Fan.		33 inches from Fan.	
Initial temperature of water ...	59·8°	71·2°	60·0°	71·2°
Final „ „ ...	59·8	59·6	60·0	60·1
Loss by evaporation, grains ...	36·8	51·2	30·4	40·0

If we assume that these results may be expressed by the formula—

$$E = A\,(T - t)\,\phi\,(w),$$

which is Fitzgerald's simplified formula, and calling E_w the evaporation from the warm water, and E_c the evaporation from the cold water, we shall have, by division—

$$\frac{E_w}{E_c} = \frac{T_w - t}{T_c - t}.$$

Now, at the distance of 15 inches from the fan, $E_w = 51·2$, $E_c = 36·8$, $T_c = 0·514$, $t = 0·267$. Substituting these values in the formula, we get—

$$T_w = 0·611 \text{ inch.}$$

At a distance of 33 inches from the fan, $E_w = 40$, $E_c = 30{\cdot}4$, $T_c = 0{\cdot}518$, $t = 0{\cdot}267$. Whence—

$$T_w = 0{\cdot}597 \text{ inch.}$$

The respective ratios, therefore, are in fair agreement, and correspond to an average temperature of 64° or 65° in the warmer water. The results in this case probably compare better with Fitzgerald's than any other that I have hitherto been able to obtain, and for that reason I hope to be able to make a series of experiments on similar lines.

A fact that stands out more clearly the more closely the subject is examined is that it is useless to attempt to deduce the true law of evaporation from the meteorological averages of extended periods, that is to say, by comparing the various elements of evaporation, average wind velocity, average temperatures of air, water, and dew-point, &c., over a day, or week, or month. These elements change so irregularly and so continuously that only short periods of time are admissible. It is not perhaps wandering far from the truth to say that under natural conditions a stationary state of affairs is never attained to; on the contrary, the temperature of the water always lags considerably behind what it would be if it could keep pace with the air temperatures, and its "personal equation" in this respect is greater as the mass of water is greater.

Observations Arranged in Order of Relative Humidity of the Air.

			Velocity in feet per Minute at distances of—				Final Temperature of the Water at Distances of—					Loss in Grains at Distances of—					$\tau-\theta$	Diff. of Vapour Tensions.
Dry Bulb.	Dew Point.	Humidity.	4 in.	13 in.	22 in.	31 in.	Still Air.	6 in.	15 in.	24 in.	33 in.	Still Air.	6 in.	15 in.	24 in.	33 in.	6 in.	6 in.
°	°	%					°	°	°	°	°						°	Inches.
92·9	35·1	13	1022	790	718	600	82·5	78·1	77·0	77·5	78·0	26·4	128·8	127·2	120·8	111·2	43·0	0·76
91·4	35·6	15	1000	830	724	668	83·0	78·0	77·0	78·0	77·8	23·2	130·4	131·2	124·0	121·6	42·4	0·75
91·0	37·4	16	1026	828	722	648	82·0	78·8	77·9	78·0	78·3	24·0	124·8	124·8	119·2	108·0	41·4	0·76
79·8	31·2	17	1064	914	836	650	77·0	69·7	69·6	69·2	70·2	14·4	101·6	104·8	100·8	86·4	38·5	0·55
87·0	42·6	21	970	910	678	644	80·6	75·1	74·9	75·2	75·4	24·8	124·0	116·0	111·2	101·6	32·5	0·60
79·1	35·0	21	1084	898	804	605	74·4	70·0	69·5	70·0	70·0	22·4	112·0	114·4	108·0	97·6	35·0	0·53
83·9	40·8	22	1010	860	792	710	80·0	74·9	74·0	74·5	74·2	24·8	110·4	119·2	107·2	104·0	34·1	0·61
86·0	45·3	25	1132	900	840	742	82·0	77·1	76·1	77·0	77·0	14·4	84·0	91·2	82·4	81·6	31·8	0·63
82·0	41·5	25	1048	928	828	756	77·1	73·0	72·0	73·0	73·5	16·0	101·6	110·4	97·6	91·2	31·5	0·55
77·0	39·6	26	1044	928	808	660	74·1	69·3	68·7	69·2	69·9	17·6	100·8	108·0	96·0	81·6	29·7	0·48
82·0	43·5	26	1074	924	840	662	75·2	73·0	72·1	73·0	73·5	(?)	97·6	100·0	87·2	76·0	29·5	0·53
84·0	45·5	27	1046	910	760	660	78·2	75·9	75·2	75·0	74·9	19·0	97·6	98·4	97·6	94·4	30·4	0·59
78·4	42·5	28	1120	860	774	624	75·9	71·3	70·4	71·0	71·0	16·8	88·0	97·6	86·4	85·6	28·8	0·49
84·1	47·1	28	1062	906	716	636	80·0	76·2	76·0	76·2	76·6	21·6	94·4	97·6	86·4	77·6	29·1	0·58
82·0	46·8	29	1020	848	744	678	79·4	75·6	75·4	75·2	75·0	22·4	96·0	95·2	92·8	88·0	28·8	0·57
86·0	52·2	31	980	856	780	600	81·5	77·6	76·6	77·1	77·1	16·8	82·4	88·0	78·4	78·4	25·4	0·56
80·0	46·0	31	1060	912	786	698	76·2	73·0	72·2	72·8	73·0	14·4	88·8	91·2	87·2	80·0	27·0	0·50
84·0	50·8	32	990	864	710	685	80·2	75·1	74·9	74·8	75·8	22·4	95·2	98·4	92·8	80·8	24·3	0·50
81·9	50·3	33	1064	868	744	644	77·7	74·8	74·0	74·1	74·7	16·0	71·2	79·2	74·4	65·6	24·5	0·50
79·0	48·3	35	1010	884	795	640	74·1	72·2	71·2	72·0	72·0	16·0	70·4	75·2	70·4	66·4	23·9	0·45
81·0	50·8	35	1000	784	724	584	78·0	73·4	73·0	72·9	73·1	16·8	72·8	72·8	76·8	65·6	22·6	0·45
74·0	44·6	35	1076	882	800	640	72·0	67·0	66·7	67·0	68·0	12·8	76·0	79·2	72·0	61·6	22·4	0·37
83·0	56·3	40	1084	890	750	678	80·0	76·2	75·6	76·0	76·6	11·2	75·2	80·8	72·8	65·6	19·9	0·45
75·0	49·1	40	1012	799	708	610	72·8	69·6	68·8	69·0	69·1	14·4	68·8	73·6	69·6	65·6	20·5	0·37
75·4	50·7	42	1096	856	750	676	74·3	69·8	69·1	69·7	69·8	12·0	70·4	74·4	67·2	60·0	19·1	0·36
78·0	53·5	43	912	802	730	568	74·5	71·8	71·2	71·5	71·8	16·0	71·2	74·4	64·8	60·0	18·3	0·37
58·8	36·5	44	1002	872	780	690	61·8	55·0	54·0	54·8	55·0	8·8	46·4	53·6	48·8	41·6	18·5	0·22
66·0	44·3	45	1106	858	796	706	65·2	61·9	61·6	62·0	62·1	8·8	54·4	57·6	55·2	50·4	17·6	0·26
76·4	54·9	48	1116	820	720	616	76·7	71·2	71·0	71·3	71·9	14·4	64·8	69·6	63·2	56·8	16·3	0·33
72·0	52·8	51	1086	912	762	584	70·9	67·6	67·0	67·5	68·0	12·0	52·8	57·6	52·8	44·8	14·8	0·27
64·0	45·7	51	1008	872	800	662	65·0	60·0	59·5	59·9	60·4	7·2	41·6	45·6	42·4	34·4	14·3	0·21
73·0	56·5	56	976	884	750	684	71·5	69·3	69·0	69·1	69·6	12·0	42·4	45·6	44·0	39·2	12·8	0·26
69·4	55·4	61	1072	954	805	644	68·0	65·1	65·0	65·2	65·4	4·8	32·8	35·2	30·4	26·4	9·7	0·18
71·1	61·1	73	1076	862	764	564	71·0	69·9	69·7	70·0	70·0	4·8	28·0	28·8	28·0	23·2	8·8	0·19

NOTE.—The quantities on the eighth line are evidently affected by some error.

NOTES ON THE ABSORPTION OF WATER BY AERIAL ORGANS OF PLANTS.

By R. Marloth, Ph.D., M.A.

(Read July 21, 1909.)

(With Plate XXVIII.)

At the last meeting of this Society a paper was presented by Dr. Schönland "On the Absorption of Water by the Aerial Organs of some Succulents." From the results of certain experiments which the author had made with several species of plants, particularly with *Mesembrianthemum barbatum*, *Anacampseros filamentosa*, and *Crassula cymosa*, he came to the conclusion that "*Mesembrianthemum barbatum* and *Anacampseros filamentosa* cannot absorb any appreciable quantity of water through their aerial organs."

It appears to me, however, that the experiments described by the author do not justify such a conclusion, especially as the conditions under which some of them were carried out are very different from those existing in nature. A twig of *Anacampseros filamentosa*, weighing 9·277 grammes, was kept in the laboratory for 7 days, when it weighed 8·672, having lost 0·605 grammes of water—that means 0·086 per day. It was then immersed in water on 5 consecutive days for 15 minutes each time, and on the sixth day for 5 hours, and then found to weigh 9·011, having gained since the last weighing 0·339 grammes.

The author considers that "the gain is evidently due to the absorption of water by the long dead hairs and not by the leaves themselves. This gain is readily acquired, but also readily parted with." The author, however, takes no notice of the loss, which the twig must have experienced during the time it was not immersed. As this time amounts to 5¾ days, and as the transpiration of the twig caused a daily loss of 0·086, the total loss during the period of the experiment from this source would have been 0·494, giving a total absorption of 0·833, acquired during 6¼ hours of immersion, while in nature the plant would have been able to continue the absorption, at certain times of the year when dew is a regular occurrence every night, for at least 60 hours during that period. As the quantity of water absorbed amounts to 0·833 grammes, or, roughly speaking, 16 drops,

while the twig weighed only 9·011 originally, it does not appear possible that this amount, which is equal to 9·2 per cent. of the weight of the twig, could have been contained in the hairs only, and that nothing of it should have passed into the tissue of the leaves.

In the case of *Mesembrianthemum barbatum* a drop of water was placed daily on the stellate hairs, and yet a twig, weighing originally 0·391, lost 0·109 in 7 days, or 27·9 per cent. of its weight. Here again the experimental conditions differ widely from those existing in nature, where the hairs would have, during 4 or 5 months of the year, at least 10 hours every night for carrying on the absorption of dew. Further, the specimens experimented with must have been in a very luxuriant condition, being probably from garden plants, for a twig of *Mesembrianthemum barbatum* taken by me from a wild plant gathered a few days before in the Karroo and kept in the laboratory for 7 days, during which the midday temperature was about 25° C., lost only 9·7 per cent. of its weight. Cultivated plants of *Mesembrianthemum barbatum* are, however, less suitable for such experiments than wild plants, for they wither much quicker, and their stellate hairs have lost much of their power of absorption. The hairs are mostly smaller, often less in number or quite absent.

Having carried out numerous experiments * with several species of plants some time ago, but with specimens brought directly from the Karroo, I had come to the conclusion that these plants are able to absorb appreciable amounts of water by means of specially constructed organs, viz., hairs, stipules, or aerial roots. I shall quote only one of these experiments here. A leaf of *Crassula tomentosa*, weighing 28·67, was kept in the laboratory for 3 days, when it had lost 0·7 grammes. By placing the leaf every night into the open, thus exposing it to the dew, while during the day it was kept in a cardboard box, it regained its original weight in 12 days, although it must have lost some more water by transpiration during that time.

A few additional experiments were made by me recently, selecting *Mesembrianthemum densum* for the purpose, as the structure of the stellate hairs of this species is quite similar to that of *M. barbatum*, of which I had no suitable specimens at my disposal. The leaves lend themselves well to such experiments, for they may be suspended in such a way that the apical hairs only touch the water, while the remainder of the leaf remains quite dry. In each case some young pairs of leaves were chosen, and having been kept in the laboratory for a few days to allow them to lose a little water by transpiration, two of them were suspended in a beaker side by side, in order to make sure that both were surrounded by air of equal relative humidity. One was a little above the water, the

* A full account of these experiments is given in Marloth, "Das Kapland," Jena, 1908, pp. 303–309.

other one just touched the surface with the tips of the stellate hairs. The results of two experiments made in June on twigs from cultivated plants, no wild plants being available, are as follows:—

I.	Initial weight of A (touching the water)	0·036
	After 3 days	0·036
	Initial weight of B (just above the water)......	0·051
	After 3 days	0·041
	Loss 0·010, equal to 20 per cent.	
II	Initial weight of A	0·137
	After 3 days	0·132
	Loss 0·005, equal to 4 per cent.	
	Initial weight of B	0·172
	After 3 days	0·139
	Loss 0·033, equal to 19 per cent.	

Thus in the one case the control specimen lost 20 per cent. of its weight by transpiration, and in the other case 19 per cent., while the leaves which were able to absorb water kept up their weight in the first experiment, and lost only 4 per cent. in the second one.

This fully confirms my previous results, viz., that the stellate hairs of *Mesembrianthemum densum* are able to absorb water from the air, and that this amount is, under certain conditions, sufficient to replace the loss suffered by transpiration.

The anatomical structure of these apical hairs is quite different from that of the ordinary water-storing epidermis-cells of the leaf. Each hair has an inflated basal part, which is inserted in a specially constructed cup. The walls of the hair itself are thick, but consist of cellulose with a very thin cuticula; those of the cup-cells, especially on adult leaves, are highly culticularised. In the young leaf the sides of the cup only possess cells with thickened walls, while the bottom part of the hair is in immediate contact with a very delicate meristematic tissue. Below this are, at the circumference of the leaf, the assimilating cells, and in the centre the colourless water-storing mesophyll of the leaf. Later the tissue immediately below the base of the hair thickens and lignifies its walls, thus forming a barrier between the base of the hair and the water-tissue of the leaf, by which further communication between the two is rendered difficult and loss of water from the interior of the leaf prevented. It is obvious that the structure of these hairs is very elaborate and highly specialised, consequently they must possess some important function in the life of the plant. Their structure during the younger stages of the leaf is well adapted to the absorption of water, and as the experiments have shown that the leaves do absorb water, it seems clear that this was obtained through the hairs, and that the hairs are specially constructed

organs of absorption. The amount absorbed may not be large, but if a leaf is able to supply itself, at least during some stages of its life, such a gain must be of importance to plants living under such extreme conditions.

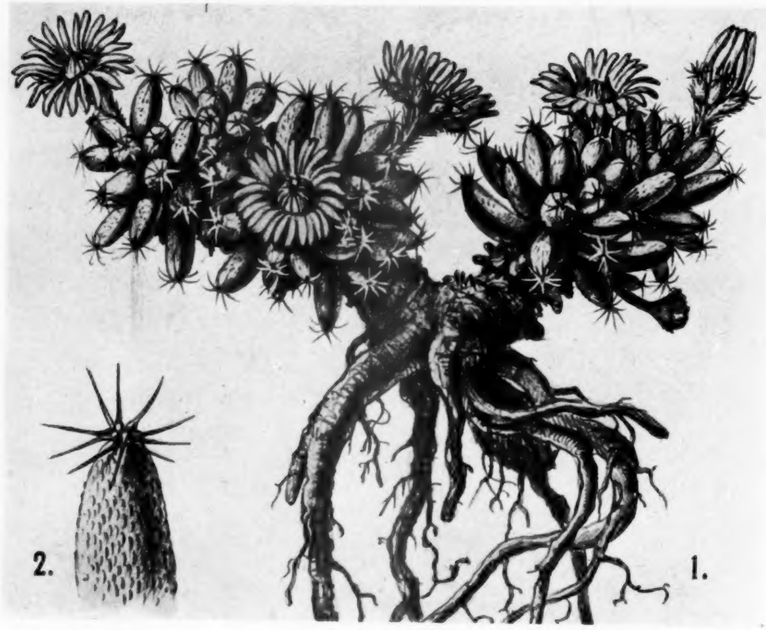
The negative results obtained by Dr. Schönland with solutions of eosin, when the hairs only were stained but not the tissue of the leaf, do not disprove the diffusion of water into the tissues. Water passes through cell walls much more readily than anilin-dyes. Seedlings of wheat or maize kept in water-cultures to which eosin has been added will, even after several days, show the staining only in the root-hairs and the epidermis-cells, but not in the central parenchyma nor in the vessels, although the shoot may have grown several inches during that time, and the roots had obviously absorbed a corresponding amount of the solution. The same phenomenon is also easily observed by suspending a strip of filter-paper in such a solution, when the water invariably rises much higher than the dye.

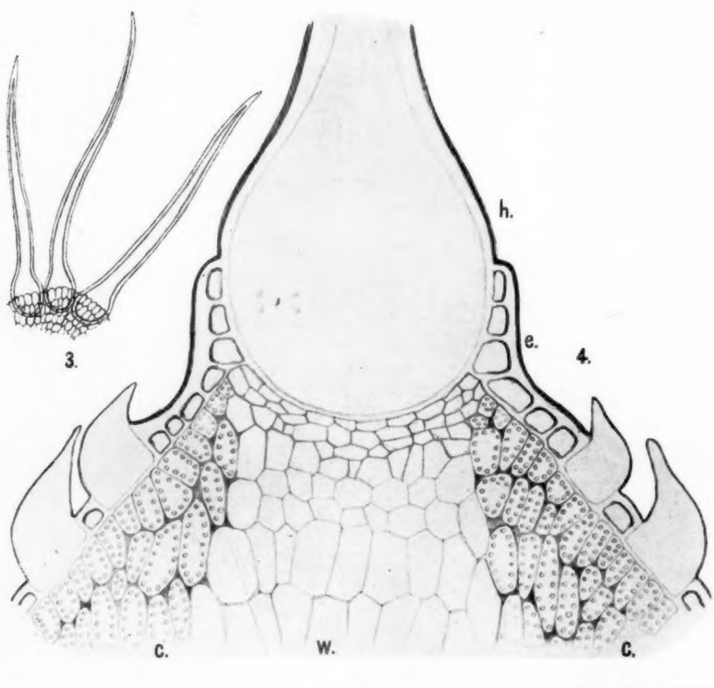
In addition to the experiment with *Crassula tomentosa* referred to above, I have recently made the following one: A young leaf, weighing 1·76 grammes, was kept in the laboratory during the month of June (temperature low, humidity of air high) for 10 days, when it weighed 1·41, having lost during that time 0·35, or 0·035 grammes per day. It was then immersed in water with the fringe of the apex for 12 hours, and found to weigh 1·69, having gained 0·28, which means that the leaf had, during one night, made good the loss experienced during 8 days by transpiration and evaporation at the cut end.

There is consequently no doubt that this plant, and, I conclude, various other succulents of our arid regions, are able to utilise the dew deposited on their leaves. I agree with Dr. Schönland that the marginal papillæ of *Crassula cymosa* and allied species are not capable of absorbing moisture. Some species may not be able to do so at all, but in others the leaves can do it, whether by means of specially constructed hairs or through the water-stomata would not matter. It is quite possible that in some species the latter mode prevails, and that the hairs and papillæ assist merely mechanically by retaining the drops of dew, which otherwise would run off too quickly. In either case the gain is so considerable that it cannot be without advantage to plants living in regions with a very scanty rainfall.

Summary.

The anatomical structure of the apical hairs of the leaves of *Mesembrianthemum densum*, Haw., and *M. barbatum*, L., show them to be well adapted to the absorption of water, at least in the younger state of the leaf.





West, Newman proc.

MESEMBRIANTHEMUM DENSUM, *Haw.*
Figs. 1, 2, 3, ex Marloth, *loc. cit.* Fig. 4, *auct. del.*

The recent experiments with *Mesembrianthemum densum* have confirmed the previous results, viz., that the leaves are capable of absorbing water by means of these hairs.

The various experiments with leaves of *Crassula tomentosa*, L., show that this plant is able to absorb a considerable amount of water through its leaves.

Dr. Schönland's experiment with *Anacampseros filamentosa* Sims, in my opinion confirms rather than opposes the view that this plant does derive some benefit from the dew deposited on its leaves and stipules.

EXPLANATION OF PLATE XXVIII.

1. *Mesembrianthemum densum*, Haw. Plant, nat. size.
2. Leaf (enlarged), showing the apical stellate hairs, each one inserted at its base in a cup.
3. Diagrammatic view of apex of leaf.
4. Tangential section through apex of young leaf, touching only one hair.

h, hair; *e*, epidermis, raised round the base of the hair and forming the cup; *c*, chlorohyll-bearing tissue; *w*, water-storing tissue.

STATEMENT OF SILAYI, WITH REFERENCE TO HIS LIFE AMONG THE BUSHMEN.

By W. E. Stanford.

(Read July 21, 1909.)

Statement of Silayi, a Tembu of the Jumba tribe, under the chief Umgudhlwa, taken at Engcobo, Tembuland, on the 7th of May, 1884 :—

About the time of the war of Umlanjeni (1850) I went to the Tsitsa River to live. The chief of our tribe was then Jumba, the present chief Umgudhlwa's father. We had previously been living on the White Kei River (Xonxa). In that part of the country there were still Bushmen families and clans and they were on comparatively friendly terms with our people as well as other Tembu tribes. I became acquainted with them through Hans, a Hottentot, and Ngqika, who was a nephew of Hans on the mother's side, his father being a Bushman of Modolo's tribe named Qako. It was with Ngqika and a son of Hans that I first visited Ngqabayi, the chief of a Bushman clan whose haunts were in the Drakensberg Mountains, about the sources of the Xuka and Qanqaru Rivers. We started off on a stock-stealing expedition from home. Ngqika advised that we should go to Ngqabayi, and join with some of the Bushmen in order to ensure success. We found the Bushmen in the Umgqazo Mountains. The clan I found could muster forty-three men. Ngqabayi was then getting old, but still active and strong. He did not take part any longer in the marauding. The men were armed chiefly with bows and arrows. They also had spears, and three had guns—Ciyo, Nkwinti, and Tyazo. The guns were flint-locks. The arrows were poisoned.

Ngqika told Ngqabayi what we had come about, and he gave us five young men to go with us to steal stock among the Dutch. We travelled along the Drakensberg Mountains until we came to the sources of the

Kraai River. There the five Bushmen grumbled with us and left us. They said we did not understand stealing, and would be in their way. They took the direction of where the township of Dordrecht now stands, and we went down the Kraai River. We found in that direction a fine troop of horses belonging to a Dutchman. We drove them off about nightfall, and each caught one to ride, having brought bridles with us. Ngqika caught a grey mare, and I picked out a brown horse, a good one. He was very fiery, and I no sooner mounted him than he commenced to buck with me. The ground was rough, and in the jumps the horse gave he fell with me, and I got my knee hurt. The others came up and lifted me up again. The horse then went quietly, and we started driving ten of the farmer's horses before us. By daylight we were in the mountains, and at sunrise we halted and slaughtered one of the horses for food; it tastes like quagga-meat.

From there we crossed over the mountains at the Ntunjankala (Gatberg) and went with the horses to the Indenxa River, near where the magistrate Thompson lived (Maclear). From there we went on to our kraal at Tsitsa, leaving the horses where we knew we should find them.

We reported what we had done, and two of the horses were handed to our chief, according to our custom. Two more we took to a trader and sold; one of these was the grey mare ridden by Ngqika. On our return from the trader, near the Bashee, we found that a party of Dutch farmers had followed the spoor of the stolen horses. This information came from the Bushman tribe. It caused alarm, and the chief had three of us caught and tied up. The Dutchmen did not appear, and we were released afterwards. This treatment we resented, because what we had done was known, and we had presented two of the horses to the chief. Ngqika and Jan said they would leave and join the Bushmen. I determined to go with them. We went off accordingly with eight of the stolen horses, and joined Ngqabayi. Jan's father, Hans, also went, and while living with the Bushmen I married his daughter Ndaralu.

The tribe was then occupying a large cave in the Pryntjesberg. Ngqabayi received us cordially, chiefly on account of Ngqika, who was half a Bushman himself. We received bows and arrows and became members of the tribe.

Our first expedition from there was under Ngqika: a brave Hottentot he was! There were twelve of us; Jan was there too, and the rest were Bushmen. We crossed the Tsomo, full, at the upper drift, and made for the Waschbank. There we found a herd of about a hundred head of cattle, and oh! there were fat oxen among them! We swam the cattle through the Tsomo after getting the whole herd away from the Waschbank, and then we slaughtered three head; we took only the breast and

the choice parts of each, and went on From there we travelled to Kowe (Slang River), and slaughtered two more oxen—fat, fat as they could be.

It is a custom of the Bush people, when any expedition like that I am describing is away, for the women and children, in searching for roots and anything they require, always to take the direction in which the men have gone, and they will travel a long way in this manner. As we returned this day with the cattle we were met by the women and children, and there was great joy over our success. That time the rain helped us, and no spoor of the cattle was ever traced.

We moved down the Gubenxa, and were attacked there by some Tembus. We then went to the Drakensberg again, near Hlankomo. After that seven of us, under the leadership of Ngqika, went again to the Waschbank and stole eighteen head of cattle, among them a big red and white ox. This time the Boers followed the spoor. They came up to us at the head of Maxongo's Hoek. We drove the cattle into an almost inaccessible place, and hid in some caves. They attacked us in them. Three of us were wounded with shot. We fought with bows and arrows; we shot a white horse belonging to them and killed it. Night came on, and they left us. We found the cattle where we had put them, and drove on in the dark. The next morning, from a neighbouring mountain, we saw the Boers following the track again, and we moved on further into the mountains and got away.

We had many expeditions of the kind I have described. Some of them we used to make into the Colony, right away to the inland districts. The Boers inland were not so sharp after us as those on the border. We lived on sheep and other stock as we went along, taking them one at a time, often in broad daylight while the herds were with the flocks, and got away unobserved. A Bushman with a skin over his shoulders would start down a donga, perhaps, and wait until the flock crossed it. He would then catch one and get away quietly; our movements were always careful. Every man we saw not of our tribe was considered and treated as an enemy. We hunted the eland, buffalo, hartebeest, and other game, and lived on it as well as on stolen cattle and horses.

The Bushmen were friendly with the neighbouring tribes, although they often stole stock from them. Sometimes a party would visit a Kafir kraal, and while some of the party asked for milk and so on, the young men would follow up from the mountain and get away with a fat ox or cow from the herd. We would afterwards pretend to assist in the search, and so throw them off the scent.

Q. What customs did they observe regarding marriage?

A. They "lobala" (pay dowry). A young man must present the father of the girl with the breast and heart of an eland before he can

get her. The girl has the band which Bush people wear round the waist, given her by the parents, and that is all that is necessary on either side.

Q. So there is no marriage ceremony?

A. None at all. There was no hut to be built, because we all slept in one cave.

Q. How were the children treated?

A. The children were treated kindly. They got their share of all we had. When young they were given decoctions of various herbs and roots. One thing the women made was a kind of thin porridge of the white ants found inside the anthills, mixed with a bulb called "incuwa" (according to Silayi's description of incuwa, it may be the *spiraxis*). The ants were roasted and water added afterwards; the bulb was pounded and dried, and then ground up to mix with the ants. I have tasted this dish and like it.

A custom I noticed among the women was to besmear themselves with the contents of the paunch of oxen we slaughtered. They would afterwards go to the nearest water and wash themselves. The men as a rule are quite naked, and the women were pretty much the same.

I was surprised to find how well the women could swim. There are many large streams rising in the Drakensberg, and these we frequently had to cross. The Bushmen do not practise the circumcision rites of the Kafirs, nor have they "intonjane." Boys and girls arrive at manhood and womanhood on marriage.

Parents are fond of their children, and, as a people, they are affectionate in their ways, but very passionate, and when in a rage don't care what they do. A quarrel between a man and his wife would generally result in dangerous weapons being used.

Q. Had they any way of hearing and deciding disputes?

A. We had disputes sometimes about game and other things. These were "talked" by Ngqabayi, the chief, and his judgments were respected.

Q. How many wives had Ngqabayi?

A. He had two; the rest had only one wife each.

Q. Did you see the poison prepared for the arrows?

A. The poison was prepared by Ngqabayi, the chief. He used the root of a shrub mixed with the bark of a tree. I know the shrub, but not the kind of tree from which he got the bark. The root and bark were boiled together in a clay pot until they became a black-looking jelly. It took days to prepare the poison; when ready, Ngqabayi served it out. The poison was deadly. Hartebeest died from it quickly, also gnus. Buffaloes were stronger and lived longer. If we wounded a buffalo in the daytime we expected to find it dead the next morning.

Q. Had they witch doctors?

A. No; they had rain doctors, and the Kafirs in the dry seasons always employed Bushmen to bring rain for them. They had medicine also for lions. There was a root we dug, which we pounded and attached to the manes and tails of the horses, together with the smelling parts of a skunk. Our horses were then safe. The root had a very unpleasant smell, and together with the skunk was too much for the lions.

Q. Did the tribe remain long in one place?

A. No; we moved from cave to cave and mountain to mountain frequently. This was to keep ourselves from observation. When pathways about any cave we occupied were noticeable we moved off.

Q. How did those who were out on hunting or thieving expeditions know where to find the tribe on their return?

A. When a cave was left a stick was always put in the ground, pointing in the direction the tribe had taken. They had tinder-boxes, got amongst the Kafirs, and we used fires also as signals.

Q. In moving along how did you proceed?

A. We moved always with the greatest caution. We had scouts out, and we had signals with the skins we wore, which we all understood.

Q. Where did they get the material with which the caves are painted?

A. It was taken out of the ground. Some kinds were prepared at the fire. They could paint very well.

Q. What did they use to paint with?

A. Hairs taken out of the tail or mane of a gnu. These hairs were tied together and fastened on a thin reed. The brush was then dipped in the prepared clay and used to paint with.

Q. Did you like your life with the Bushmen?

A. Yes, I got on very well with them. I left them at last on account of my people sending for me. Hans and Ngqika left the tribe at the same time. Hans and Ngqika afterwards went to the Qokolweni Mission Station, and I returned home. Afterwards they went to Adam Kok's country.

Q. What became of the Bushmen?

A. Ngqabayi and his tribe were attacked about the time of Nongqause (1858) by Umgndhlwa. They had stolen his cattle. The women and children were nearly all killed. Only two boys and one woman, Ngqabayi's daughter, escaped. Ngqabayi himself and a few of his men got away and took refuge in Umditshwa's country. After that they went back to the mountains, and the last news I heard of them was that they were about the sources of the Umzimvubu River (St. John's).

I am now a Christian, having joined the Mission at Lucwecwe two years before the last Gcaleka War, through which I served under you. It

was in that war that I saw that I was really converted. I came home without stealing a horse or a cow out of the stock captured.

Q. How long were you in the mountains with the Bushmen?

A. Nearly three years.

Q. Did you pick up their language?

A. I got to hear (*i.e.*, to understand) what they said, and I could talk a little with them. (Silayi here made use of some Bushman sentences which he remembered.)

SILAYI, his × mark.

Witness, W. E. STANFORD.

The names given by Silayi were pronounced by him in Kafir, the language in which he was speaking.

ON SOME FLOWERING PLANTS FROM THE NEIGHBOURHOOD OF PORT ELIZABETH.

By S. Schönland, Ph.D., F.R.S.S.Af.

(With two figures in the text.)

During the last few years Mr. I. L. Drege, of Port Elizabeth, and Mrs. T. V. Paterson, of Redhouse, near Port Elizabeth, have supplied me with a large number of plants from their neighbourhood. Many of these were of extreme interest. Amongst them were some previously known only from other districts of Cape Colony. Many were only known to me from Ecklon and Zeyher's collections, and there were also a fair number which seemed to me undescribed. Some of these are still under consideration. In the meantime I offer herewith the descriptions of a few species which I think are undoubtedly new, and I have added a description and figure of an extremely variable species of *Polyxena* (*P. ensifolia*) which was first described and figured by Thunberg as *Mauhlia ensifolia*, but placed by many subsequent botanists under *P. pygmæa*.

Eriospermum dregei, Schönl., n. sp.
Fig. 1.

Tuber subovatum diam. c. 5 cm. × c. 2·5 cm., protuberantiis rotundatis munitum. Folium solitarium hysteranthum petiolatum, petiolo lanato c. 4 cm. longo, lamina late ovata apice subplicata c. 2 cm. longa c. 1·5 cm. lata supra minutissime puberula vel glabra subtus lanata, basi processu alcicorni erecto lanato c. 4 cm. longo munita, processus subdichotome ramosus ramis primariis 4–6 subverticillatis reliquis furcato-multifidis, terminalibus oblanceolatis. Pedunculus erectus simplex filiformis glaber e basi vacue bracteatus incl. racemo c. 7·5 cm. altus, racemo denso c, 1·5 cm. longo 10–15-floro, bracteis minutis ovato-acutis c. 2 mm. longis albidis rubro-carinatis, pedicellis inferioribus c. 4 mm. longis superioribus

gradatim minoribus. Flores erecto-patentes c. 5 mm. longi, petalis oblongis, exterioribus pallide viridibus marginibus albidis, interioribus albidis stria longitudinale pallide viridi ornatis. Stamina quam petala ½ breviora filamentis late ovatis antheris minutis late ovatis. Ovarium subglobosum stylo subulato brevior. Capsula ignota.

Fig. 1.—Eriospermum Dregei, Schönl. (½ nat. size.)

Port Elizabeth — Mr. I. L. Drege. Flowers in March; the leaf being produced about April.

There has hitherto been only one species of *Eriospermum* described in which the leaf bears a single compound process at the base of the lamina, namely, *E. paradoxum*, Gawl., which seems to be only known from Jacquin's figure, and certainly our species comes very close to it, but in *E. paradoxum* the filaments are linear, while in our species they are broadly ovate; further, the ultimate branches of the foliar process are much finer in *E. paradoxum*, though in our species they are also sometimes finer than shown on fig. 1.

Albuca (§ Eu-Albuca) patersoniæ, Schönl., n. sp.

Glaberrima; bulbus globosus vel depresso-globosus 4–5 cm. diam., tunicis exterioribis albidis lævissimis apice fibrillosis. Folia 3–5 linearia canaliculato-conniventia, itaque subteretia, ad 25 cm. longa. Pedunculus teres ebracteatus 8–12 cm. longus. Racemus subcorymbosus pauciflorus, bracteis lanceolatis cuspidatis c. 10 mm. longis, pedicellis incurvis inferioribus c. 15 mm. longis superioribus gradatim minoribus. Flores erecti, petalis exterioribus c. 23 mm. longis albidis cum stria utrinque media rubescenti, interioribus c. 19 mm. longis albidis cum stria utrinque media viridi. Stamina exteriora antheris minutissimis et sterilibus; cæterum ut in subgenere.

Redhouse, near Port Elizabeth—Mrs. T. V. Paterson (No. 460), February, 1909.

This species is allied to *A. altissima*, Dryand., but is easily distinguished by its very narrow leaves, the edges of which are turned

inwards so as to nearly touch one another, and also by the terminal fibres of the bulb-tunics.

LACHENALIA ALGOENSIS, Schönl., n. sp.

Bulbus subglobosus vel depresso-globosus c. 10 mm. diam. Folia 2 sublinearia tenuia subplicata dorso convexa 14–24 cm. longa basi vaginantia, vagina 5–9 cm. longa basi albida. Pedunculus ebracteatus 10–17 cm. longus pallide viridis maculis rubridis irregulariter ornatus leviter applanatus; racemus 4–5 cm. longus 4–10 florus, floribus superioribus incompletis, bracteis minutis ovatis acuminatis, pedicellis brevissimis, floribus erecto-patentibus c. 19 mm. longis. Perianthium oblongum leviter compressum, petalis exterioribus pallide viridibus ventricosis 2 anterioribus subæqualibus, 1 posteriori quam anteriora 2 mm. longiori, tubo c. 4 mm. longo, lobis c. 12–15 mm. longis, posteriori infra apicem dorso gibboso; petalis interioribus albidis aut ætate rubescentibus ad faucem tubi insertis, quam interiora 2–4 mm. longioribus apice leviter recurvatis et emarginatis. Stamina stylusque petala paullo excedentia; filamenta alba, pollen flavum. Capsula ignota.

Port Elizabeth, I. L. Drege (No. 64); Redhouse, Mrs. T. V. Paterson (No. 92). Flowers in August.

This species is nearly allied to *L. reflexa*, Thunb., from which it is distinguished by narrow, longer, and not falcate leaves, further by a much shorter corolla-tube, besides the flowers are not yellowish. The vagina of the foliage-leaves is sometimes distinctly umbonate on the back.

POLYXENA ENSIFOLIA (Thunb.), Schönl.
Fig. 2.

Bulbus subglobosus vel ovoideus 12–30 mm. diam. Folia 2–3, infimum vaginans membranaceum nondum abest, 2 foliacea ex vaginis hypogæis ovato-acuta ensifolia vel lanceolata suberecta vel patentia utrinque glabra ad margines versus vaginas tennuiter ciliata vel lævia cæterum scabriuscula, 3–15 cm. longa. Inflorescentia corymbosa pauciflora, pedunculo 3 mm.–6 cm. longo, bracteis parvis lanceolatis albis, pedicellis 3–5 mm. longis. Perianthium tubo albo cylindrico c. 15 mm. longo semsim ad faucem dilatato, segmentis lilacinis obovato-lanceolatis obtusis 7–9 mm. longis, suberectis apice leviter recurvatis. Stamina biseriata ad faucem perianthii inserta, exteriora lobis perianthii $\frac{1}{3}$ breviora, interiora iis $\frac{2}{3}$ breviora, antheris minutis oblongis filamentis filiformibus. Ovarium trigonum oblongum compressum, stylus filiformis, stigma capitatum. Capsulam maturam non vidi.

Found near Uitenhage, Port Elizabeth, and Grahamstown; also at Beaufort West (?).

Flowers in winter, especially June. The following specimens belong to it: Zeyher 757 (on the banks of the Bushman's River and on hills near Addo) and Schlechter 2600 (Uitenhage), I. L. Drege 43*a*, 119 (Port Elizabeth), Miss M. Daly and Miss M. Sole 203, and W. G. Bennie 500 (Grahamstown).

The extreme variability of this species in the shape and size of the leaves and of the length of the peduncle is remarkable. The style is dimorphous, sometimes reaching to the level of the inner stamens, in other cases reaching to the level of the outer ones. The flowers have an unpleasant though not very pronounced smell.

Fig. 2.—Polyxena. (½ nat. size.)

It looks sometimes very much like *Lachenalia kunickiana*, Schlecht. (Schlechter 10471) but is quite distinct from it. I do not know, however, why Schlechter placed his plant under *Lachenalia* and not under *Polyxena* to which it seems to belong.

I have no doubt that Thunberg's plant collected between the Sundays River and Fish River, and described by him, though imperfectly, as *Mauhlia ensifolia* (Prodr., p. 60, and Flora Cap., ed. Schult., p. 308) is our plant. Unfortunately, the illustration in his Prodr. (t. 1) is very poor, and this has probably led to its being included in *Polyxena pygmæa*, Kunth., a plant of which very good illustrations were published by Jaquin (Ic. ii., t. 380), by Redouté (Lil., t. 386), and in the Bot. Mag. (t. 554). The other illustrations quoted by Baker under *P. pygmæa* in the Flora Cap., vi., p. 421, are not known to me. Zeyher, who collected both species, referred his Lislap plant (No. 1716) rightly to *P. pygmæa*, while he referred the specimens from the neighbourhood of Uitenhage (No. 757) to *Massonia angustifolia*, Spr. It is, however, very different from this species (now known as *Polyxena angustifolia*, Bak.) as represented by Bot. Mag. (t. 736).

The chief differences between *P. pygmæa* and *P. ensifolia* are as follows: In *P. pygmæa* the tube of the corolla is three times longer than the limb, in *P. ensifolia* it is only about double the size; in the former the limb is spreading from the base, and the segments are strongly recurved,

in the latter it is nearly upright and the segments are only slightly recurved at the apex; in *P. pygmæa* the three longer stamens nearly equal the segments, in *P. ensifolia* they are one-third shorter; moreover, in the latter the stamens are more decidedly biseriate.

MACROSTYLIS (?) PATERSONIÆ, Schönl., n. sp.

Fruticulus ramosissimus caule ramisque sub-teretibus. Ramuli squarrosi grisei densissime foliati. Folia alternantia erecto-adpressa dense imbricata brevissime petiolata acicularia subtrigona breviter mucronata dorso convexa carinata supra leviter concava ad margines minute ciliata cæterum glabra punctis glandulosis biseriatis ornata 5–7 mm. longa. Flores solitarii terminales breviter pedicellati involucrati, foliis involucri 4–5 sepalis similibus sed brevioribus. Sepala membranacea ovata subnavicularia dorso carinata ad margines minutissime ciliata 6 mm. longa persistentia. Petala spathulata mucronata 10 mm. longa lilacina erecto-patentia basi ad margines ciliata facie infra medium transversaliter puberula. Filamenta subulata 2 mm. longa antheræ oblongæ mucronatæ, stamina sterilia 0. Discus hypogynus urceolatus integerrimus supra ovarium connivens stylo perforatus. Ovarium 5-lobum lobis obtusis rotundatis; stylus brevissimus post anthesin elongatus, deinde 2 mm. longus; stigma capitatum. Cocci oblique obovati intus versus apicem oblique truncati apice bicorniculati.

Red House, Mrs. T. V. Paterson (No. 322)—Nov., 1908.

This species is obviously closely allied to both *Macrostylis*, Bartl. and Wendl. and *Euchætis*, Wendl., and if I put it under the former I do so chiefly because the style elongates after the flower has opened. On the other hand, it has a capitate stigma which is more characteristic for *Euchætis*. Then it has also the short stamens of *Euchætis*, but on the other hand, the discus overtops the ovary as in *Macrostylis*. A future monographer of the *Rutaceæ* may perhaps have to make it the type of a new genus. To show more clearly how difficult it is to place this species into either of the above genera, I append the remarks on *Macrostylis* by Bartling and Wendland (Beiträge zur Botanik, 1. Heft, Göttingen, 1824, p. 193) by which they try to emphasise the distinctions between them: "Genus et notis essentialibus et habitu facile distinguendum, solummodu Euchætidi affine, quæ vero staminibus brevissimis, stylo brevi post anthesin immutato, stigmate capitato, disci hypogyni margine vix libero nec germen occultante, foliis margine impunctatis et floribus non fastigiatis abunde differt."

CRASSULA PATERSONIÆ, Schönl., n. sp.

Fruticulosa ramis erectis carnosis dense foliatus glabris teretibus internodiis 5–7 mm. longis. Folia decussata connata perfoliata late

ovata apice obtusa vel mucronulata subplana carnosa viridia margine rubra, intus versus margines punctis brunneo-rubridis ornata ad margines pilis albis retrorse ciliata, inferiora c. 25 mm. longa c. 20 mm. lata, superiora gradatim decrescentia. Inflorescentia terminalis laxe thyrsiodea multiflora subcorymbosa pedunculo brevissimo nudo vel bracteis 2 vacuis munito c. 4 cm. longo, thyrso c. 7 cm. longo, bracteis foliis similibus sed gradatim valde minoribus, superioribus minutis acutis c. 1 mm. longis. Flores breviter pedicellati. Sepala basi connata 1·5 mm. longa lobis ovatis c. 1 mm. longis. Petala alba basi connata ovata erecto-patentia apice recurvata 2 mm. longa. Stamina petalis paullo minora, filamentis albis subulatis antheris rubro-brunneis late oblongis; ovaria oblique ovata c. 1·2 mm. longa stylis rubridis subulatis c. 0·75 mm. longis. Squamæ minutæ cuneatæ apice rotundatæ pallide luteæ.

Cradock place near Port Elizabeth, Mr. E. E. Galpin, May, 1902; Bethelsdorp, Mrs. T. V. Paterson (No. 664), June, 1909.

Although I have known this species since the year 1902, I have hitherto abstained from describing it, as in Mr. Galpin's specimen the inflorescence had evidently been injured. It is very closely allied to *Cr. perfoliata*, Linn. f., from which it can be distinguished at a glance by its shorter and much looser inflorescence which almost resembles a corymb. *Cr. perfoliata* has, further, a much shorter calyx, yellowish submucronulate petals, rather broader squamæ and exibits other minor differences.

LAURENTIA RADICANS, Schönl., n. sp.

Herba perennis cæspitosa ramosissima ramis 2–3 cm. longis filiformibus reptantibus ad nodos radicantibus internodiis 1–3 mm. longis. Folia petiolata, petiolo applanato c. 4 mm. longo, lamina plana textura subcarnosa ovato-lanceolata acuta basi cuneata c. 6 mm. longa dorso medio leviter canaliculata, supra leviter carinata utrinque minutissime puberula. Flores versus apicem ramulorum axillares pedicillati, pedicellis tenuibus 3 mm. longis; calycis lobi 0·75 mm. longi ovato-lanceolati dorso convexi; corolla subregularis indistincte bilabialis, petalis patentibus deinde reflexis subliberis pallide roseis lanceolatis 1·5 mm. longis; stamina 1·25 mm. longa petalis basi adnata filamentis albis applanatis basi inter se liberis apicem versus connatis, antheris brunneis 0·6 mm. longis, 2 posticis seta una munitis, tubus antherarum obliqe ovatus; ovarium subhemisphæricum dimerum multi-ovulatum, c. 0·5 mm. longum; stigmata 2 brevissima subreniformia; capsula apice bivalvata subhemisphærica c. 1 mm. longa.

On damp clayey ground near Port Elizabeth; Mr. I. L. Drege, June, 1909.

This is evidently the smallest species of *Laurentia* known, and although the other species vary considerably it seems to be quite distinct. Its entire leaves and its almost free petals characterise it sufficiently.

BORCHARDT'S FORM OF THE ELIMINANT OF TWO EQUATIONS OF THE nth DEGREE.

By Thomas Muir, LL.D., F.R.S.

(Read September 15, 1909.)

1. The problem which Borchardt set for himself was to express the eliminant of the equations $\phi(x)=0$, $\psi(x)=0$, both of the nth degree, in terms of $n+1$ arbitrary values of x and the corresponding values of $\phi(x)$, $\psi(x)$. To this end he made use of the result of Cayley's mode of finding Bezout's condensed eliminant; and as a consequence his solution took the form of an expression in terms of the $\frac{1}{2}n(n+1)$ different values of

$$\frac{\phi(x)\psi(y)-\phi(y)\psi(x)}{y-x}$$

found by giving x and y the said $n+1$ arbitrary values, say, $a_0, a_1, \ldots, a_n$. He experienced difficulty, of course, when x and y had to be given one and the same value; but this was overcome by establishing the theorem that *If* $\phi(x)$, $\psi(x)$ *be rational integral functions of the* nth *degree, and* $\{\phi(x)\psi(y)-\phi(y)\psi(x)\}\div(y-x)$ *be denoted by* $\mathrm{F}(x,y)$ *and* $(x-a_0)(x-a_1)\ldots(x-a_n)$ *by* $f(x)$, *then*

$$\frac{\mathrm{F}(a_r,a_r)}{f'(a_r)} = -\sum_s \frac{\mathrm{F}(a_r,a_s)}{f'(a_s)}$$

where s *is given in succession all the values* $0, 1, \ldots, n$, *except* r. In other words, he succeeded in showing that each of the $n+1$ illusory forms becomes known as a consequence of knowing n of the other forms.*

2. The mode of proof given by him is laborious, the two given functions being expressed in the interpolational form

$$\sum_{r=0}^{r=n}\frac{f(x)/(x-a_r)}{f'(a_r)}\,\phi(a_r), \qquad \sum_{r=0}^{r=n}\frac{f(x)/(x-a_r)}{f'(a_r)}\,\psi(a_r),$$

* For marked advances recently made on Borchardt's work the reader is referred to two papers by Mr. A. L. Dixon in the *Proceed. Lond. Math. Soc.* (2), vi. pp. 468–478, vii. pp. 49–69.

the operations involved in $\phi(x)\psi(y)-\phi(y)\psi(x)$ then performed, and the terms of the result combined in groups of four so as to admit of the factor $y-x$ being struck out preparatory to making the substitution $x=y=a_r$.

A much simpler mode would have been to take $\phi(x)\psi'(x)-\phi'(x)\psi(x)$ as the limiting form of $\{\phi(x)\psi(y)-\phi(y)\psi(x)\}\div(y-x)$, and then substitute for $\phi'(a_r)$, $\psi'(a_r)$ the expressions obtained from the interpolational forms of $\phi(x)$, $\psi(x)$ by dividing by $x-a_r$ and thereafter putting $x=a_r$.

3. As is often the case, however, the whole matter suffers as regards simplicity by reason of excessive specialisation. The following much more general theorem is susceptible of a much simpler proof. *If $\Phi(x, y)$ be used to stand for*

$$\begin{array}{cccc|l} 1 & x & \ldots & x^{n-1} & \\ \hline a_{11} & a_{12} & \ldots & a_{1n} & 1 \\ a_{21} & a_{22} & \ldots & a_{2n} & y \\ \ldots & \ldots & \ldots & \ldots & \vdots \\ a_{n1} & a_{n2} & \ldots & a_{nn} & y^{n-1}, \end{array}$$

and $\zeta^{\frac{1}{2}}$ for the difference-product of any quantities following it, then

$$\zeta^{\frac{1}{2}}(\alpha_1\alpha_2\ldots\alpha_n)\,.\,\Phi(\alpha_0\alpha_0) - \zeta^{\frac{1}{2}}(\alpha_0\alpha_2\ldots\alpha_n)\,.\,\Phi(\alpha_0\alpha_1) + \zeta^{\frac{1}{2}}(\alpha_0\alpha_1\alpha_3\ldots\alpha_n)\Phi(\alpha_0\alpha_2)$$
$$-\ldots\ldots+(-1)^n\zeta^{\frac{1}{2}}(\alpha_0\alpha_1\ldots\alpha_{n-1})\,.\,\Phi(\alpha_0\alpha_n)=0.$$

By way of proof we have only to seek for the co-factor of a_{rs} on the left-hand side. Now in $\Phi(x, y)$ this co-factor is seen to be $y^{r-1}x^{s-1}$, therefore the full co-factor sought is

$$\zeta^{\frac{1}{2}}(\alpha_1\alpha_2\ldots\alpha_n)\,.\,\alpha_0^{r-1}\alpha_0^{s-1}. - \zeta^{\frac{1}{2}}\alpha_0\alpha_2\ldots\alpha_n)\,.\,\alpha_0^{r-1}\alpha_1^{s-1} + \zeta^{\frac{1}{2}}(\alpha_0\alpha_1\alpha_3\ldots\alpha_n)\,.\,\alpha_0^{r-1}\alpha_2^{s-1}$$
$$-\ldots\ldots+(-1)^n\zeta^{\frac{1}{2}}(\alpha_0\alpha_1\ldots\alpha_{n-1})\,.\,\alpha_0^{r-1}\alpha_n^{s-1}$$

which is seen to be the development of

$$\alpha_0^{r-1}(-1)^n\begin{vmatrix} 1 & \alpha_0 & \alpha_0^2 & \ldots & \alpha_0^{n-1} & \alpha_0^{s-1} \\ 1 & \alpha_1 & \alpha_1^2 & \ldots & \alpha_1^{n-1} & \alpha_1^{s-1} \\ \ldots & \ldots & \ldots & \ldots & \ldots & \ldots \\ 1 & \alpha_n & \alpha_n^2 & \ldots & \alpha_n^{n-1} & \alpha_n^{s-1} \end{vmatrix}$$

arranged according to the elements of the last column of the determinant. As, however, s is not greater than n, the said last column must be identical with a preceding column; and thus the theorem is proved.

Borchardt's special case of this is where the square array in the expression of $\Phi(x,y)$ is the peculiar axisymmetric array of Bezout's condensed eliminant, for then by Cayley's theorem $\Phi(x,y)$ becomes

$$\{\phi(x)\psi(y)-\phi(y)\psi(x)\}\div(y-x) \quad \text{or} \quad F(x,y).$$

Thus, when $n=3$ we have

$$0 = \zeta^4(a_1a_2a_3).\mathrm{F}(a_0)a_0 - \zeta^4(a_0a_2a_3).\mathrm{F}(a_0a_1) + \zeta^4(a_0a_1a_3).\mathrm{F}(a_0a_2) - \zeta^4(a_0a_1a_2).\mathrm{F}(a_0a_3),$$

from which on division by $\zeta^4(a_0a_1a_2a_3)$ there results

$$\begin{aligned} 0 = &- \frac{\mathrm{F}(a_0a_0)}{(a_0-a_1)(a_0-a_2)(a_0-a_3)} + \frac{\mathrm{F}(a_0a_1)}{(a_1-a_0)(a_1-a_2)(a_1-a_3)} \\ &- \frac{\mathrm{F}(a_0a_2)}{(a_2-a_0)(a_2-a_1)(a_2-a_3)} + \frac{\mathrm{F}(a_0a_3)}{(a_3-a_0)(a_3-a_1)(a_3-a_2)}, \end{aligned}$$

and thence

$$\frac{\mathrm{F}(a_0a_0)}{f'(a_0)} = -\frac{\mathrm{F}(a_0a_1)}{f'(a_1)} - \frac{\mathrm{F}(a_0a_2)}{f'(a_2)} - \frac{\mathrm{F}(a_0a_3)}{f'(a_3)}$$

if $f(x)$ be put for $(x-a_0)(x-a_1)(x-a_2)(x-a_3)$.

4. Another proposition of Borchardt's occurring in the same memoir is also readily generalisable, the fundamental theorem being that *If an array of* n − 1 *rows and* n *columns be such that the sum of every one of the rows vanishes, the principal minor determinants of the array, when taken alternately positive and negative are equal to one another.* The array being

$$\begin{array}{cccc} a_{11} & a_{12} & \dots & a_{1n} \\ a_{21} & a_{22} & \dots & a_{2n} \\ \dots & \dots & \dots & \dots \\ a_{n-1,1} & a_{n-1,2} & \dots & a_{n-1,n} \end{array}$$

and M_r being the minor determinant whose array is obtained from the given array by deleting the rth column, we have only to ascertain the relation between M_1 and M_r. To do this we remove the rth column from its place in the given array, and attach it by addition to the first column, thus forming a *square* array whose determinant

$$\left|\begin{array}{ccccccc} a_{11}+a_{1r} & a_{12} & \dots & a_{1,r-1} & a_{1,r+1} & \dots & a_{1n} \\ a_{21}+a_{2r} & a_{22} & \dots & a_{2,r-1} & a_{2,r+1} & \dots & a_{2n} \\ \dots & \dots & \dots & \dots & \dots & \dots & \dots \\ a_{n-1,1}+a_{n-1,r} & a_{n-1,2} & \dots & a_{n-1,r-1} & a_{n-1,r+1} & \dots & a_{n-1,n} \end{array}\right|$$

by reason of the data vanishes, and being partitionable into two gives

$$\mathrm{M}_r + (-1)^{r-2}\mathrm{M}_1 = 0$$

and ∴

$$\mathrm{M}_r = (-1)^{r-1}\mathrm{M}_1$$

as desired.

This is virtually the same as saying that *If the sum of every row, except one, of a determinant be* 0, *the co-factors of the elements of the excepted row are identical.* Consequently we can assert that *Any determinant which has the sum of every row equal to zero has in the case of every row the same co-factor for every element of the row ;* and from this it follows at once that *Any axisymmetric determinant which has the sum of every row equal to zero has the co-factors of all the elements identical*—which is Borchardt's theorem.

5. It is very doubtful, however, whether it is desirable to view this common co-factor as a determinant at all; for when it is of the nth order it is a function of only $\frac{1}{2}n(n+1)$ elements and yet contains $(n+1)^{n-1}$ terms and all of them positive. Thus

$$\begin{vmatrix} a_2+b_3+b_4 & -b_3 & -b_4 \\ -b_3 & a_3+b_3+c_4 & -c_4 \\ -b_4 & -c_4 & a_4+b_4+c_4 \end{vmatrix},$$

which is a function of the six quantities a_2, a_3, a_4, b_3, b_4, c_4, is equal to

$$\begin{aligned} a_2a_3a_4 + a_2a_3(b_4+c_4) + a_2a_4(b_3+c_4) + a_3a_4(b_3+b_4) \\ + (a_2+a_3+a_4)(b_3b_4+b_3c_4+b_4c_4). \end{aligned}$$

Further, although it is of the third order, there are not two but three other ways of writing it like this; and, generally, $n+1$ ways in all in the case of the nth order—a property unnatural to a determinant. The reason, of course, is that these $n+1$ ways correspond to the co-axial primary minors of the determinant of the $(n+1)$th order whose primary minors are all equal.

6. Much more convenience results from arranging the $\frac{1}{2}n(n+1)$ elements in semi-quadrate form, that is to say, in the manner in which the elements of a pfaffian are arranged; and if after doing this we bracket them in some specially distinctive way, we shall at the same time secure a convenient notation. Thus, we shall have

$$\left|\left\{\begin{matrix} a_2 & a_3 & a_4 \\ & b_3 & b_4 \\ & & c_4 \end{matrix}\right\}\right|$$

instead of the determinant in the preceding paragraph, and

$$\left|\left\{\begin{matrix} a_2 & a_3 \\ & b_3 \end{matrix}\right\}\right| \quad \text{instead of} \quad \begin{vmatrix} a_2+b_3 & -b_3 \\ -b_3 & a_3+b_3 \end{vmatrix}.$$

Further, towards the formulating of a recurrent law of formation for the new function we shall have the following identities :—

$$\left|\left\{a_2\right\}\right| = a_2, \quad \left|\left\{\begin{array}{cc} a_2 & a_3 \\ & b_3 \end{array}\right\}\right| = (a_2 + a_3)\left|\left\{b_3\right\}\right| + a_2 a_3,$$

$$\left|\left\{\begin{array}{ccc} a_2 & a_3 & a_4 \\ & b_3 & b_4 \\ & & c_4 \end{array}\right\}\right| = (a_2 + a_3 + a_4)\left|\left\{\begin{array}{cc} b_3 & b_4 \\ & c_4 \end{array}\right\}\right| \begin{array}{l} + a_2 a_3 \left|\left\{b_4 + c_4\right\}\right| + a_2 a_4 \left|\left\{b_3 + c_4\right\}\right| \\ + a_3 a_4 \left|\left\{b_3 + b_4\right\}\right| + a_2 a_3 a_4, \end{array}$$

$$\left|\left\{\begin{array}{cccc} a_2 & a_3 & a_4 & a_5 \\ & b_3 & b_4 & b_5 \\ & & c_4 & c_5 \\ & & & d_5 \end{array}\right\}\right| = (a_2 + a_3 + a_4 + a_5)\left|\left\{\begin{array}{ccc} b_3 & b_4 & b_5 \\ & c_4 & c_5 \\ & & d_5 \end{array}\right\}\right| + \Sigma a_2 a_3 \left|\left\{\begin{array}{cc} b_4 + c_4 & b_5 + c_5 \\ & d_5 \end{array}\right\}\right|$$

$$+ \Sigma a_2 a_3 a_4 \left|\left\{b_5 + c_5 + d_5\right\}\right| + a_2 a_3 a_4 a_5,$$

and so forth. With the double-suffix notation for the elements, or with the umbral notation, the details of the law are still more readily grasped. Thus the next identity of the series may be written

$$\left|\left\{\begin{array}{cccc} 1_2 & 1_3 & \ldots & 1_6 \\ & 2_3 & \ldots & 2_6 \\ & & \ldots\ldots & \\ & & & 5_6 \end{array}\right\}\right| = 1_2 + 1_3 + \ldots + 1_6)\left|\left\{\begin{array}{cccc} 2_3 & 2_4 & 2_5 & 2_6 \\ & 3_4 & 3_5 & 3_6 \\ & & 4_5 & 4_6 \\ & & & 5_6 \end{array}\right\}\right| + \Sigma 1_2 1_3 \left|\left\{\begin{array}{ccc} 2_4 + 3_4 & 2_5 + 3_5 & 2_6 + 3_6 \\ & 4_5 & 4_6 \\ & & 5_6 \end{array}\right\}\right|$$

$$+ \Sigma 1_2 1_3 1_4 \left|\left\{\begin{array}{cc} 2_5 + 3_5 + 4_5 & 2_6 + 3_6 + 4_6 \\ & 5_6 \end{array}\right\}\right| \begin{array}{l} + \Sigma 1_2 1_3 1_4 1_5 (2_6 + 3_6 + 4_6 + 5_6) \\ + 1_2 1_3 1_4 1_5 1_6, \end{array}$$

where we observe that by deleting the first element of the co-factor of 1_2, and then combining the 1st and 2nd frame-lines by addition we obtain the co-factor of $1_2 1_3$; and by treating similarly the co-factor of $1_2 1_3$ we obtain the co-factor of $1_2 1_3 1_4$: and so on.

7. The development being arranged according to products of elements of the first line, what is required for practical purposes is a rule for telling the co-factor of such a product; and this is easily formulated. Thus, if the co-factor of $1_5 1_6$ be wanted, we note that the indices not found in $1_5 1_6$ are 2, 3, 4, and thence form the triangular array

$$\begin{array}{cc} 23 & 24 \\ & 34, \end{array}$$

thereafter prefixing to this array the line of three elements got from taking 2 along with 5 and 6, 3 along with 5 and 6, and 4 along with 5 and 6, the result being

$$\left|\left\{\begin{array}{ccc} 2_5 + 2_6 & 3_5 + 3_6 & 4_5 + 4_6 \\ & 2_3 & 2_4 \\ & & 3_4 \end{array}\right\}\right|$$

Similarly the co-factor of $1_4 1_5 1_6$ is found to be

$$\left|\left\{\begin{array}{cc} 2_4+2_5+2_6 & 3_4+3_5+3_6 \\ & 2_3 \end{array}\right\}\right|.$$

8. The development, however, may also be arranged according to products of elements of any other frame-line than the first. Thus, taking the *third* frame-line $1_3, 2_3, 3_4, 3_5, 3_6$, and seeking the co-factor of $2_3 3_5$, we first note that the indices not found in $2_3 3_5$ are 1, 4, 6, and we thereupon form the triangular array

$$\begin{array}{cc} 14 & 16 \\ & 46, \end{array}$$

to which we next prefix the line of three elements got from taking 1 along with 2 and 5, 4 along with 2 and 5, and 6 along with 2 and 5, the full co-factor sought being

$$\left|\left\{\begin{array}{ccc} 1_2+1_5 & 2_4+4_5 & 2_6+5_6 \\ & 1_4 & 1_6 \\ & & 4_6 \end{array}\right\}\right|.$$

This suggests that the third, and indeed any, frame-line may be made the first; and we readily find that the procedure necessary to effect the transformation is (1) to delete the third frame-line from the given triangular array, and write it again as the first frame-line of a new array, and (2) to complete the said new array by appending the undeleted minor of the original array, the result being

$$\left|\left\{\begin{array}{ccccc} 1_3 & 2_3 & 3_4 & 3_5 & 3_6 \\ & 1_2 & 1_4 & 1_5 & 1_6 \\ & & 2_4 & 2_5 & 2_6 \\ & & & 4_5 & 4_6 \\ & & & & 5_6 \end{array}\right\}\right|.$$

Since any frame-line may thus occupy any one of the available places, the number of different modes of writing the function of the nth degree is $(n+1)\,!$, the last mode being got from the first by not only reversing the order of the frame-lines but also reversing the order of the elements in each: for example, the first and last modes of writing the function of the 4th degree are

$$\left|\left\{\begin{array}{cccc} a_2 & a_3 & a_4 & a_5 \\ & b_3 & b_4 & b_5 \\ & & c_4 & c_5 \\ & & & d_5 \end{array}\right\}\right| , \quad \left|\left\{\begin{array}{cccc} d_5 & c_5 & b_5 & a_5 \\ & c_4 & b_4 & a_4 \\ & & b_3 & a_3 \\ & & & a_2 \end{array}\right\}\right|.$$

REVISED LIST OF THE FLORA OF NATAL.

SUPPLEMENT* CONTAINING APOCYNACEÆ, ASCLEPIADEÆ, CORRECTIONS, AND ADDITIONS.

COMPILED BY J. MEDLEY WOOD.

APOCYNACEÆ.

Landolphia Kirkii Dyer, var. **delagoensis** Dewevre. North-Eastern part of Zululand only.

Carissa arduinia Lam. Below 1,000 feet, *Drege;* near Durban, *Peddie;* Inanda, 1,800 feet, *Wood,* 300 (10); Nottingham, 4–5,000 feet, *Buchanan,* 137; between Maritzburg and Newcastle, *Wilms,* 2132; without precise locality, *Gueinzius, Cooper,* 1103, 1235; *Sanderson; Gerrard,* 147; Polela, 4–5,000 feet, *Fernando* in Govt. Herbarium, 10467.

2. **C. grandiflora** A. DC. Woods near Durban Bay, *Krauss,* 88; *Peddie; Nelson,* 44; *Grant; Wilms,* 2133; between Umtentu and Umzimkulu Rivers, *Drege,* and without precise locality, *Gerrard,* 755, *Cooper,* 1235. "There are long and short-styled flowers, the long-styled ones being functionally female, the others male" (M. S. Evans in "Natal Plants," t. 14). It is strictly a coast plant.

3. **C. Wylei** N. E. Brown. 'Ngoya, Zululand, 1–2,000 feet, *Wylie* (*Wood,* 7898, 8631).

Acokanthera spectabilis Hook. Near Point, Durban, *Krauss,* 361; near Durban, *Wood,* 1017 (9); woods along the coast, *Wood* in Macowan Herb. Austr. Afr., 1501; and without precise locality, *Cooper,* 1247, 1262, 1263; *Gerrard* 88. In Natal strictly a coast plant.

2. **A. venenata** G. Don. Inanda, 1,800 feet, *Wood,* 982; Mount Moreland, 50 feet, *Wood* (7), and without precise locality, *Gerrard,* 139. Sim considers these two to be forms of one species, but with this as at present advised I cannot agree.

Rauwolfia natalensis, Sond. Umzinyati River, *Wood,* 648; without precise locality, *Bowker, Gerrard,* 1585.

Lochnera rosea Reichb. Near Durban, *Wilms,* 2131; near Durban, 100 feet, *Wood,* 8695 (9), and without precise locality, *Cooper,* 2748, 2749; *Grant.* A naturalised weed in coast districts.

Conopharyngia ventricosa Stapf. Woods near Umgeni River, *Krauss,* 146; Inanda, 1,500–2,000 feet, *Wood,* 787; near Durban, *Wood,* 8441 (11); Umlaas Location, 500 feet ? *Wood* in Govt. Herbarium, 2604 (7); without precise locality, *Keit* in Natal Govt. Herbarium, 479 (leaves only). Formerly known as *Tabernæmontana ventricosa* Hochst.

* The Revised List was published in Part 2 of Vol. XVIII., 1908, of the *Transactions of the South African Philosophical Society.*

Yoacanga Dregei E. M. Between Umtentu and Umkomanzi Rivers, *Drege ;* forest near Umlaas River, *Krauss*, 27; near Pinetown, 1,000 feet, *Rehmann*, 8027; same locality, *Wood*, 3841 (2); Umlalazi River 1-200 feet, *Wood*, 10296 (3); without precise locality, *Gueinzius, Gerrard*, 408, *Sutherland*. The insertion of **V. Thouarsii** R. and S. in "Handbook to the Flora of Natal," is an error, this plant is a native of Madagascar.

Wrightia natalensis Stapf. Near Umzinyati River, 500 feet, *Haygarth* in Herb. *Wood*, 7891 (9). This is quoted in "Flora Capensis" as *Wood*, 7861, it should be as above stated, 7891. Very rare, only as yet found in the locality quoted.

Strophanthus Gerrardi Stapf. *Gerrard*, 1795. Not known to us.

2. **S. speciosus** Reber. Blinkwater, near York, *Wood*, 4305 (4); Qudeni forest, 6,000 feet, *Davis*, 5, in Herb. *Wood*, 7895; Dronk Vlei, *Fernando* (*Wood*, 9926) (1). Eshowe, Zululand, *Hon. Mrs. Evelyn Cecil*, 275, and without precise locality, *Mrs. Saunders ; Nicholson* (*Wood*, 8697).

Oncinotis inandensis Wood and Evans. In woods, Inanda, 1,800 feet, *Wood*, 1009 (9); same locality, *Wood*, 6159 (10). A stout climber reaching to tops of the tallest trees, where the flowers are produced in abundance. Also in Pondoland, as reported by T. R.-Sim.

Pachypodium Saundersii N. E. Brown. Zululand, South-Eastern Lebombo Mountains, in very stony places, *Saunders*. Only known to us in cultivation near Durban.

Adenium multiflorum Klotzsch. Zululand, Lebombo country, *Saunders*. Not seen by us.

ASCLEPIADEÆ.

Cryptolepis capensis Schltr. In woods, Inanda, 1,800 feet, *Wood*, 761, 1583 (1); Bluff near Durban, 2-300 feet, *Wood ;* without precise locality, *McKen*, 6; 21. A slender climber with yellow flowers.

2. **C. oblongifolia** Schlechter. On stony hills and borders of woods from the coast to at least 3,000 feet. Near Umgeni, *Krauss ;* Inanda, 1,800 feet, *Wood*, 446 (1-4), near Durban, *Gerrard*, 595; Field's Hill, 1,500 feet, *Wood*. An erect undershrub, formerly known as *Ectadiopsis oblongifolia* Bth.

Raphionacme divaricata Harv. Inanda, 2,000 feet, *Wood*, 368 (12). The insertion in "Flora Capensis" of *Wood*, 527, is an error. Various collectors at from a few feet to 3,000 feet above sea-level.

2. **R. elata** N. E. Brown. Inanda, 1,500 feet, *Wood*, 849 (11); Zululand, *Haygarth* (*Wood*, 7567) (12), without precise locality, *Gerrard* and *McKen*, 1301. The flowers in all specimens seen by us are green.

3. **R. Flanagani** Schltr. Tugela, *Gerrard*, 1312; near Umkomaas, 3,000 feet, *Schlechter*, 6691. Camperdown, 2,000 feet, *M. Franks* (*Wood*, 11,078).

4. **R. Galpinii** Schlechter. Groenberg, 2,000 feet, *Wood*, 1032 (9); Inanda, *Wood*, 1060 (10); Clairmont, 20 feet, *Wood*, 4925 (9), Reit Vlei, *Fry* in Herb. *Galpin*, 2750; Krantzkloof, 1,400 feet, *Schlechter*, 3213.

Tacazzea Kirkii, N. E. Brown. Zululand, without precise locality, *Gerrard* 1796. Not known to us.

2. **T. natalensis** N. E. Brown. On a stony hill in dense bush, Umbogentwini, 3-400 feet, *Wood*, 3634 (7), removed to Botanic Gardens, Durban, where it lived for several years, but died without fruiting; also without precise locality, *Gerrard*, 780.

Chlorocodon Whytei Hook. Inanda, 1,800 feet, *Wood;* Karkloof forest, and 'Ngoya forest, Zululand, *Wood;* and cultivated specimens. A variety of this plant is in the Botanic Gardens, Durban, which bears flowers of dull greenish white, not purple. Figured and described in "Natal Plants," vol. i., pl. 31.

Secamone Alpini Schultes. Inanda, *Wood*, 1415 (11); *Wilms*, 2230; *Peddie;* Shepstone, 100 feet; *Rogers*, 599. Formerly known as *S. Thunbergii.*

2. **S. frutescens** Dcne. Inanda, *Wood*, 638 (10); without precise locality, *Gerrard*, 133; *Cooper*, 1158. Not uncommon at margins of woods.

3. **S. Gerrardi** Harv. Near Durban, climbing over tops of trees, *Gerrard* and *McKen*, 86, 513; near Durban, 150 feet, *Wood*, 4497 (11); in woods, Inanda, 2,000 feet, *Wood*, 622 (11).

Woodia mucronata N. E. Brown, var. **trifurcata** N. E. Brown. Zululand, Ntondweni, *Wood*, 10831 (12).

2. **W. verruculosa** Schlechter. Hills near Camperdown, 2-3,000 feet, *Wood*, 4079 (10), 4966 (10). Rare in Natal, on this species Schlechter founded the genus.

Xysmalobium asperum N. E. Brown. Without precise locality, *Gerrard*, 1951. Not known to us.

2. **X. confusum** Scott-Elliott. Highlands of Natal, *Gerrard*, 1282; Inanda, 1,800 feet, *Wood*, 1163 (11); without precise locality, *Mrs. Saunders;* Zululand, *Wood*, 10840.

3. **X. Gerrardi** Scott-Elliott. Field's Hill, near Pinetown, 1,500 feet, *Wood*, 3398 (10), Krantzkloof, 1,500 feet, *Wood*, 5002 (10); between Maritzburg and Greytown, *Wilms*, 2136; without precise locality, *Gerrard*, 1289; *Sanderson*, 179; *Mrs. Saunders.*

4. **X. involucratum** Dcne. Inanda, 1,800 feet, *Wood* 364 (12); Mooi River, 4,000 feet, 4063 (11); Shafton, *Mrs. Hutton*, 403; near mouth of the Umzimkulu River, *Drege;* Tugela, *Gerrard*, 1801; *Sanderson*, 373; *Peddie;* Inanda, 1,800 feet, *Wood* in Natal Govt. Herbarium, 429.

X. orbiculare D. Dietr. Near Verulam, 300 feet. *Wood* 912 (4); Umhlongwe, 2-500 feet, *Wood*, 3013 (4); Inanda, 1,800 feet, *Wood*, 1254 (4); Zululand, *Wood*, 3924, 5677 (4); without precise locality, *Gueinzius;* *Gerrard*, 1284.

6. **X. parviflorum** Harv. Dargle, 3-4,000 feet, *Fannin*, 41; Reit Vlei, *Fry* in Herb. *Galpin*, 2742; Weenen County, 3-6,000 feet, *Sutherland;* Van Reenen, 5,500 feet, *Wood*, 6633 (11); Nottingham Road, 4,800 feet, *Wood*, 6805 (10); *Wilms*, 2137; *Gerrard*, 1288. Usually found on rocky hills.

7. **X. Stockenstromense** Scott-Elliott. South Downs, Weenen County, 4,000 feet, *Wood*, 4419 (12); also in Umvoti County, 3-3,500 feet, *Wood* (3).

8. **X. tysonianum** N. E. Brown. Niginya, 5,500 feet, *Wylie* in Herb. *Wood*, 11087 (10).

9. **X. undulatum** R. Br. Near Estcourt, 3,800 feet, *Wood*, 3474 (12); Botha's Hill, 2,000 feet, *Wood*, 4809; without precise locality, *Cooper*, 2745.

10. **X. Woodii** N. E. B., n. sp. Van Reenen, 5–6,000 feet, *Wood*, 10830 (1).

Periglossum angustifolium Dcne. Lynedoch, 4–5,000 feet, *Wood*, 4547 (2); Charlestown, 5,500 feet, *Wood*, 5548 (2); Congella, 40 feet, *Schlechter*, 3070; near Maritzburg, *Krauss*, 171; without precise locality, *Mrs. Hutton*, 307; *Gerrard*, 1293; *Mrs. Fannin*, 89.

2. **P. Mackenii** Harv. Near Durban, *McKen*, 664; *Gueinzius*. Not seen by us.

Cordylogyne globosa E. M. Near Charlestown, 5–6,000 feet, *Wood*, 4797 (12), "Flowers green and white"; same locality, *Wood*, 5142 (1), "Flowers yellow"; same locality, *Wood*, 5548 (2), "Flowers red-brown"; near Newcastle, 4,000 feet, *Wood*, 6227 (1), "Flowers yellow"; Reit Vlei, *Fry* in Herb. *Galpin*, 2738; Drakensberg Mountains, *Sutherland*. The colour of the flowers as quoted are taken from my collecting book.

Krebsia corniculata Schlechter. Near Buffalo River, *Gerrard*, 1309, 2162. Not known to us.

2. **K. stenoglossa** Schltr. Zululand, Ntondweni, *Wood*, 10837 (12).

Schizoglossum altissimum Schlechter. Near Estcourt, 3,800 feet, *Wylie* in Herb. *Wood*, 10695 (2).

2. **S. araneiferum** Schlechter. Near Newcastle, 4,100 feet, *Schlechter*, 3428; Newcastle, 3,800 feet, *Wood*, 10814 (12). A note in the "Flora Capensis" states, "The corona of this is quite unlike any other known to me, and in fresh flowers forms a pretty miniature crown."

3. **S. atropurpureum** E. Meyer. Drakensberg, Oliver's Hoek Pass, 5–6,000 feet, *Wood*, 3471 (1), Buffalo River Valley, 5–6,000 feet, *Wood*, 5368 (1). "The tuber is sweet tasted and is eaten by the Basutos, according to a note in Herb. *Bolus*.

4. **S. biflorum** Schlechter. Shafton, Howick, 3–4,000 feet, *Mrs. Hutton*, 301; near Newcastle, 3,900 feet, *Wood*, 5897 (12). Var. **integrum.** Same locality, *Wood*, 5901 (12).

5. **S. Buchanani** N. E. Brown. Without precise locality, *Buchanan*. Not known to us.

6. **S. carinatum** Schlechter. Attercliffe, 800 feet, *Sanderson*, 449, partly; Inanda, 1,800 feet, *Wood*, 1404 (11); near Pinetown, 1,000 feet, *Schlechter*, 3165; Clairmont, 20 feet, *Wood* (10); Zululand, *Gerrard*, 1313.

7. **S. ciliatum** Schlechter. Near Howick, 3,800 feet, *Wood*, 5357 (11); Dargle, 3–4,000 feet, *Fannin*, 40; Camperdown, 2,500 feet, *Wood* (10).

8. **S. commixtum** N. E. Brown. Shafton, Howick, 3–4,000 feet, *Mrs. Hutton*, 206, partly, mixed with **S. Woodii** Schltr. Near Durban, 1–200 feet, *Wood*, 11166.

9. **S. contracurvum** N. E. Brown. Reit Vlei, 4–5,000 feet, *Fry*, in Herb. *Bolus*, 2747. Not known to us.

10. **S. cordifolium** E. Meyer. Umzinyati, 500 feet (?), *Wood*, 1040 (9); 'Ngoya, Zululand, 2,000 feet, *Wood*, 8271 (4); Shafton, Howick, 3–4,000 feet, *Mrs. Hutton*, 43; without precise locality, *Gerrard*, 2166.

11. **S. decipiens** N. E. Brown. South Downs, Weenen County, 5,000 feet, *Wood*, 4395 (12).

12. **S. elingue** N. E. Brown. Drakensberg, 6–7,000 feet, *Evans*, 358. Not collected by us.

13. **S. euphorbioides** E. Meyer. Sea-coast near Umzimkulu, *Drege;* between Umzimkulu and Umkomaas Rivers, *Drege*, 4960; Umkomaas, *McKen*, 4; without precise locality, *Drege*, 4959. Not known to us.

14. **S. exile** Schlechter. Between Umzimkulu and Umkomaas Rivers, *Drege*, 4978. Not known to us.

15. **S. flavum** Schlechter. Near Nottingham Road, 4–5,000 feet, *Wood*, 5358 (11). Var. **lineare** N. E. B. Dargle Farm, 3–4,000 feet, *Fannin*, 48; Drakensberg, *Bolus* in Herb. *Guthrie*, 4878. Not common.

16. **S. glabrescens** Schlechter, var. **longirostre** N. E. B. Shafton, Howick, *Mrs. Hutton*, 466. Not seen by us; the type does not appear to have been collected in Natal, but in Transvaal only.

17. **S. glanduliferum** Schlechter. Near Charlestown, 5,500 feet, *Wood*, 4804 (12).

18. **S. grandiflorum** Schltr. Inchanga Hills, 3,800 feet, *Schlechter*, 3246*b*.

19. **S. hamatum** E. Meyer. Insiswa Mountain, *Schlechter*, 6438; *Krook*, 800; Dargle Farm, 3–4,000 feet, *Fannin*, 63. Not known to us.

20. **S. ingomense** N. E. Brown. Ingoma, Natal, *Gerrard*, 1302, partly. Unknown to us. "Similar to but quite distinct from **S. cordifolium,** yet difficult to characterise."

21. **S. interruptum** Schlechter. Hills near Maritzburg, *Krauss* (ex *Meisner*).

22. **S. lamellatum** Schlechter. Near Colenso, 3–4,000 feet, *Schlechter*, 3375; without precise locality, *Mrs. Saunders*, in Natal Govt. Herbarium, 7094.

23. **S. Macowani** N. E. Brown. The type collected in Cape Colony and Transkei. Var. **tugelense** N. E. Brown. Tugela, *Gerrard*, 1807. Not known to us.

24. **S. nitidum** Schlechter. Dargle Farm, 3–4,000 feet, *Fannin*, 18, 19; Shafton, Howick, 3–4,000 feet, *Mrs. Hutton*, 40*a*, 410; Mooi River district, *Wood*, 5578 (10); hill near Mooi River, *Wood*, 5378 (11); near Newcastle, 3,800 feet, *Wood* in Natal Govt. Herbarium, 7740.

25. **S. orbiculare** Schlechter. Wessels Neck, 4300, rare, *Schlechter*, 3395. Not seen by us.

26. **S. pachyglossum** Schlechter. Krantzkop, *McKen*, 16; near Boston, 3–4,000 feet, *Wood*, 5760 (2), "Flowers green"; near Enon, 2–3,000 feet, *Wood*, 1873 (4); Zululand, 4–5,000 feet, *Wylie* (*Wood*, 10, 680), "Flowers white and green" (3); without precise locality, *Buchanan*, 151. Var. **abbreviatum** N. E. Brown. Without precise locality, *Gerrard*, 1303. This plant is evidently very variable, not only in the corona lobes and colour of flowers, but also in size of leaves, pubescence, and height of stems, one of the Zululand specimens has stems of 3 feet in length, and some in other collections of 2 feet or more.

27. **S. parcum** N. E. Brown. Inanda, 1,800 feet, *Wood*, 287 (10); near Pinetown, 1–2,000 feet, *Schlechter*, 3166; without precise locality, *Mrs. Saunders*.

28. **S. parile** N. E. Brown. Shafton, Howick, 3–4,000 feet, *Mrs. Hutton*, 40, 405; near Howick, 3–4,000 feet, *Wood*, 10681 (11).

29. **S. Pegleræ** N. E. Brown. Botha's Hill, 2,000 feet, *Wood*, 10700 (2).

30. **S. pilosum** Schlechter. Near Emberton, 1,800 feet, *Schlechter*, 3238; Liddesdale, 4–5,000 feet, *Wood*, 4256 (12) (not 4256 from Van Reenen); Reit Vlei, 4–5,000 feet, *Fry* in Herb. *Galpin*, 2748; Shafton, Howick, 3–4,000 feet, *Mrs. Hutton*, 404; Zululand, *Gerrard*, 1308. In a note to this plant in the "Flora Capensis" Mr. Brown says: "The method of fertilisation of this plant would appear to be of a very special and complicated nature, as the unusually large basal teeth or lobules alternating with the corona-lobes so completely cover and conceal the opening at the base of the anther-wings, through which alone access to the stigma can be obtained, that it is difficult to understand how the pollen-masses can be inserted in it by an insect, as they must be for fertilisation to take place."

31. **S. pulchellum** Schlechter. Dargle Farm, *Fannin*, 16; Shafton, Howick, *Mrs. Hutton*, 406; Van Reenen, 5,500 feet, *Wood*, 4256 (not 4256 from Liddesdale); near Howick, 3–4,000 feet, *Wood*, 10683 (11); "Flowers pale green"; Zululand, Entumeni, 1–2,000 feet alt., *Wood* (4), "Flowers yellow."

32. **S. robustum** Schlechter. Near Boston, 3–4,000 feet, *Wood*, 5369 (2); Umzinto, 100 feet, *infra McKen*, 3; Howick, 3–4,000 feet, *Junod*, 194; near Ixopo, *Schlechter*, 6659; Umgeni Valley, *Krook*, 824 (ex *Schlechter*); without precise locality, *Mrs. Saunders*. Var. **pubiflorum.** N. E. Brown. Krantzkop, *McKen*, 21; near Durban, *Gueinzius;* Var. **inandense** N. E. Brown. Inanda, 1,800 feet, *Wood*, 316, partly (11); without precise locality, *Gerrard*, 1316. The following numbers, specimens of which are in the Govt. Herbarium, are typical **S. robustum,** but have been distributed as **S. verticillare** *Schlechter:* Manderston, 1,900 feet, *Wood*, 5386 (2); foot of the Drakensberg, 3–4,000 feet (1); the following two are in the Herbarium under the same name, but have not been distributed—Cedara, 3–4,000 feet, *Wylie* (2); Estcourt, 3–4,000 feet, *Wylie* (2).

33. **S. stenoglossum** Schlechter. Dargle Farm, *Fannin*, 36; Reit Vlei, *Fry* in Herb. *Galpin*, 2749; between Botha's and Gillitt's, 1,800–2,200 feet, *Wood*, 3397 (10); Van Reenen, 5,500 feet, *Wood*, 4561, 4778, 5009 (10, 11, 12); between Maritzburg and Greytown, *Wilms*, 2144; Sebundini, Zululand, *Haygarth* (*Wood*, 7554) (12).

34. **S. striatum** Schlechter. Inanda, 1,800 feet, *Wood*, 863 (3); 1210 (2), *Mrs. Saunders* (ex *Schlechter*).

35. **S. strictum** Schlechter. Near Ingagane, 3–4,000 feet, *Schlechter*, 3405. Not known to us.

36. **S. tubulosum** Schlechter. Attercliffe, 800 feet, *Sanderson*, 449, partly; Inanda, 1,800 feet, *Wood*, 740 (12); near Newcastle, 4,200 feet, *Schlechter*, 3410; Nondweni, Zululand, *Wood*, 10686 (12).

37. **S. unicum** N. E. Brown. Ingoma, Zululand, *Gerrard* and *McKen*, 1317. Not known to us.

38. **S. verticillare** Schlecter. Near Emberton, 2,000 feet, *Schlechter*, 3242; Inanda, 1,800 feet, *Wood*, 316, partly (11), 863 (3), 1434; near Howick, 3–4,000 feet, 10682 (11); Dargle Farm, 3–4,000 feet, *Fannin*, 6; Reit Vlei, *Fry*, in Herb. *Galpin*, 2746; and without precise locality, *Gerrard*, 1307.

39. **S. virens** E. Meyer. Between Umtsikaba River and Durban, *Drege*, 4956; on a hill at Umhlongwe, 500 feet, *Wood*, 3012 (4); and without precise locality, *Gerrard*, 1302, partly.

40. **S. Woodii** Schlechter. Near Howick, 3–4,000 feet, *Wood*, 3472 (12); same locality, *Wood*, 5382; *Mrs. Hutton*, 206, partly; near Mooi River, *Schlechter*, 3339, near Emberton, 1,800 feet, *Schlechter*, 3231; Inchanga 2,000 feet, *Wood*, 7563 (11); Attercliffe, 800 feet, *Sanderson*, 508. The quotation in "Flora Capensis," "and in Natal Herbarium, 667" is incorrect, as also a similar one under **S. virens**, "and in Natal Herbarium, 489," which is *Wood*, 3012, Umhlongwe, 300 feet (?) (4), while 667 is *Wood*, 3472, as above quoted; these errors were undoubtedly caused by the private distribution number having been sent instead of the collector's number.

41. **S. auriculatum** N. E. Br. Howick 3,800 feet, *Wood*, 5385 (11).

Fanninia caloglossa Harv. Dargle Farm, *Fannin*, 49. Not seen by us. Mr. Brown says: "This is one of the most beautiful of South African Asclepiads, and well worth cultivating."

Asclepias affinis Schlechter. Richmond, *Krook*, 816; Shafton, Howick, *Mrs. Hutton*, 402; Umkomaas River, *Schlechter*, 6682. Not known to us.

2. **A. albens** Schlechter. Near Umlaas River, *Krauss*, 84; near Durban, *McKen*, 826; Inanda, 1,800 feet, *Wood*, 101; Port Shepstone, *Rogers*, 523; Botha's Hill, 2–3,000 feet, *Wood*, 6648. A very common species from coast to at least 3,000 feet.

3. **A. aurea** Schlechter. Near Newcastle, *Schlechter*, 3409. Var. **vittata** N. E. B. Biggarsberg, 4–5,000 feet, *Wood*, 4555 (11); near Newcastle 3,900 feet, *Wood*, 5892 (12).

4. **A. bicuspis** N. E. Brown. Dargle Farm, 3–4,000 feet, *Fannin*, 50. Not known to us.

5. **A. brevicuspis** Schlechter. Between Umzimkulu and Umkomaas, *Drege*, 4966; Mount Moreland, 60 feet, *Wood*, 960 (7); near Durban, 50 feet, *Wood*, 10811 (9); Zululand, *Mrs. McKenzie*, 1–200 feet, *Wood*, 5682 (4); *Gerrard*, 322; *Sanderson*, 149; *Peddie; Mrs. Saunders*. Common in coast districts.

6. **A. cucullata** Schlechter. Van Reenen, 5,500 feet, *Wood*, 4820 (11), 5384 (12), 5667 (11), between Greytown and Newcastle, *Wilms*, 2141; Reit Vlei, *Fry* in Herb. *Galpin*, 2741; Shafton, Howick, *Mrs. Hutton*, 41, 347, 407. Not uncommon.

7. **A. cultriformis** Harv. Dargle Farm, 3–4,000 feet, *Fannin*, 85; Shafton, Howick, 3–4,000 feet, *Mrs. Hutton;* Inanda, 1,800 feet, *Wood*, 405 (1); without precise locality, *Sanderson*, 291; Zululand, *Gerrard*, 1296. Not uncommon.

8. **A. decipiens** N. E. Brown. Mooi River, 4–5,000 feet, *Gerrard*, 1290. Not seen by us.

9. **A. Dregeana** Schlechter. Table Mountain, Natal, *Krauss*, 470; Dargle Farm, 3–4,000 feet, *Fannin*, 12; Inanda, 1,800 feet, *Wood*, 350 (1); near Charlestown, 5–6,000 feet, *Wood*, 5643 (1); Krantzkloof, 1–2,000 feet, *Schlechter*, 3195; without precise locality, *Gerrard*, 1295; *Sanderson*, 241, 514; *Mrs. Saunders*, 8. Formerly known in Natal as *Gomphocarpus marginatus* Schl.

10. **A. eminens** Schlechter. Near Estcourt, 4,000 feet, *Wood*, 3477; Colenso, *Krook*, 823; Zululand, *Gerrard*, 1291; Newcastle, 4,000 feet, *Wood*, 10812 (12); Buffalo Valley, near Charlestown, *Wood*, 4692 (12).

11. **A. flava** N. E. Brown. Dargle Farm, 3–4,000 feet, *Fannin*, 13, 39; Liddesdale, 4–5,000 feet, *Wood*, 4249 (11); Lidgetton, *Wood*, 6255; Shafton, Howick, 3–4,000 feet, *Mrs. Hutton*, 408; without precise locality, *Gerrard*, 1315.

12. **A. flexuosa** Schlechter. Between Umzimkulu and Umkomaas Rivers, *Drege*, 4965; near Durban, *Gerrard*, 514; *Sanderson*, 258; *Peddie;* near Umlaas River, *Krauss*, 343; Inanda, 1,800 feet, *Wood*, 280 (10), Flowers pink; near Howick, 3–4,000 feet, *Wood*, 5378 (11), Flowers lilac and white; Clairmont, 20 feet, *Wood*, 8269, Flowers pinky white (9); Zululand, 'Ngoya, 1–2,000 feet, *Wylie* (*Wood*, 5680), Flowers lilac; without precise locality, *Mrs. McKenzie*. It is quite possible that the collecting tickets may have been written in the evening, or on the morning after the specimens were collected, which may account partly for the discrepancies in noting the colour of the flowers.

13. **A. fruticosa** Linn. Near Greytown, *Wilms*, 2142; near Ladysmith, 3–4,000 feet, *Wood*, 4755 (2); and without precise locality, *Gueinzius*. Very plentiful round Ladysmith, the stems contain a fibre which may prove to be of economic value.

14. **A. gibba** Schlechter. Mooi River, 4–5,000 feet, *Wood*, 4064 (11); various localities, *Sanderson*, 164; *Mrs. Clark; Fannin*, 46; *Wilms*, 2140; *Sutherland*. Var. **media** N. E. Brown. Zululand, *Gerrard*, 1291 *bis*.

15. **A. macropus** Schlechter. Hillsides, Lynedoch, 4–5,000 feet, *Wood*, 4544 (2); Mooi River, 3–4,000 feet, *Wood* (1), 5374; Dargle Farm, 3–4,000 feet, *Fannin*, 90; slopes of Drakensberg near Tugela Falls, *Wood;* Van Reenen, 5,500 feet, *Wood*, 10712 (1).

16. **A. Meyeriana** Schlechter. Tugela Falls near Colenso, 3–4,500 feet, *Wood*, 4108 (10); *Schlechter*, 3,378 (9); *Krook*, 788; near Ladysmith, *Schlechter;* near Dundee, 4,400 feet, *Wood*, 6544 (10).

17. **A. multicaulis** Schlechter. Greenwich Farm, Reit Vlei, *Fry* in Herb. *Galpin*, 2740; Estcourt, 4,500 feet, *Schlechter*, 3355 (9, 10).

18. **A. peltigera** Schlechter. Between Umkomaas and Umlaas Rivers, *Drege* (ex *E. Meyer*). Inanda, 1,800 feet, *Wood*, 362 (11); near Umzumbi, 100 feet, *Wood* (4).

19. **A. physocarpa** Schlechter, near Durban, *Cooper*, 2716; *Wood*, 33, 39; without precise locality *Gerrard*, 439; *Sutherland*, *Sanderson*, *Gueinzius*, not uncommon on coast districts, while the nearly allied **A. fruticosa** L. is confined to the midlands, and perhaps the upper districts also. The stems of both contain a useful fibre which has been favourably reported on.

20. **A. præmorsa** Schlechter. Krantzkloof, 1–2,000 feet, *Wood*, 1162 (10); 'Ngoya, Zululand, 1–2,000 feet, *Wood*, 5678 (4); near Murchison, *Wood*, 3040.

21. **A. reenensis** N. E. Br. Van Reenen, 5–6,000 feet, *Wood*, 8635.

22. **A. schizoglossoides** Schlechter. *Groom* in Herb. *Wood*, 1408; Van Reenen, 5–6,000 feet, *Wood*, 6576 (11); near Richmond, 2,800 feet, *Wood*, 10819 (11). Very rare.

23. **A. stellifera** Schlechter. Klip River, *Sutherland;* Dargle Farm, 3-4,000 feet, *Fannin*, 17. Sabamhlope, 6,000 feet, *Wylie* (*Wood*, 11397).

24. **A. vicaria** N. E. Brown. Near Boston, 3–4,000 feet, *Wylie* (*Wood*, 5371) (2); only known from this locality in Natal, also in Pondoland near Fort Donald, 4,500 feet, *Tyson*, 1749.

25. **A. Woodii** Schlechter. Dargle Farm, *Fannin*, 34; near Howick, 3,500–3,700 feet, *Wood*, 4258 (12), 5121; Reit Vlei, *Fry* in Herb. *Galpin*, 2743; near Maritzburg, *Wilms*, 2138. In a note Brown says: "The granules in the very thin membrane of the anther appendages are remarkable, and I do not recollect having seen them in any other species; they appear to be crystals of oxalate of lime."

Pachycarpus appendiculatus E. Meyer. Krantzkloof, 1,400 feet, *Schlechter*, 3216; Zululand, *Gerrard*, 1286; Somkele, *Wood*, 10832 (12).

2. **P. asperifolius** Meisn. Margins of woods round Durban Bay, *Krauss*. An imperfectly known species; in a note Brown says, "Described as resembling **P. appendiculatus,** but differing in the leaves tapering below, the spreading corolla, and form of the corona lobes." We have not met with it.

3. **P. campanulatus** N. E. Brown. Near Durban, *Sanderson;* Dargle Farm, 3-4,000 feet, *Mrs. Fannin*, 5; Inanda, 1,800 feet, *Wood*, 79, 1326; hills near Charlestown, 5–6,000 feet, 5151, mixed with var. **Sutherlandi;** without precise locality, *Gerrard*, 2161, 2164. Var. **Sutherlandi,** Drakensberg, 5–6,000 feet, *Sutherland;* Biggarsberg, *Gerrard*, 1298.

4. **P. concolor** E. Meyer. Shafton, Howick, 3-4,000 feet, *Mrs. Hutton*, 513; Rock Fountain, *Mrs. Clarke;* without precise locality, *Gerrard*, 1282 *bis*. 'Ngoya, Zululand, 1–2,000 feet, *Wylie* (*Wood*, 5681) (4).

5. **P. dealbatus** E. Meyer. Insiswa Mountains, *Krook*, 808 (?); near Hoffenthal, 4,000 feet, *Wood*, 3473 (12); bank of Tugela River, 4,500 feet, *Wood*, 3475 (1); Biggarsberg, 4–5,000 feet, *Wood*, 4247.

6. **P. decorus** N. E. Brown. Without precise locality, *Gerrard*, 1278. Also in Transvaal. Not known to us.

7. **P. Gerrardi** N. E. Brown. Ingome, *Gerrard*, 1299. Not known to us.

8. **P. grandiflorus** E. Meyer. Hills above Byrnetown, 4,000 feet, *Wood*, 3169 (3); near Lynedoch, *Wood;* near Durban Bay, *Krauss*, 1260. *Wood's* 589 and 962 are wrongly numbered, the collector's number not having been sent.

9. **P. inconstans** N. E. Brown. Margins of woods near Durban, *Krauss*, 83; Inanda, 1,800 feet, *Wood*, 1075 (11); near Pinetown, 1,500 feet, *Wood*, in Natal Govt. Herbarium, 3712 (1).

10. **P. natalensis** N. E. Brown. Inanda, 1,800 feet, *Wood*, 470 (12), 1420 (11); Inchanga, 2,100 feet, *Wood*, 6641 (10); Greenwich Farm, Reit Vlei, *Fry* in Herb. *Galpin*, 2744; Dargle Farm, *Fannin*, 35.

11. **P. plicatus** N. E. Brown. Valley of Buffalo River, near Charlestown, 5–6,000 feet, *Wood*, 4801 (12); hillside at Rock Fountain, *Mrs. Clarke.*

12. **P. rostratus** N. E. Brown. Zululand, 4–5,000 feet, *Haygarth* in Herb. *Wood*, 7543 (12).

13. **P. scaber** N. E. Brown. Inanda, 1,800 feet, *Wood*, 468 (12); Greenwich Farm, Reit Vlei, *Fry* in Herb. *Galpin*, 2745; Umkomaas Valley, *Krook*, 821; Zululand, *Gerrard*, 1285.

Pentarrhinum coriaceum Schlechter. *Gerrard* and *McKen.* A very doubtful species. (Brown in "Flora Capensis.")

2. **P. insipidum** E. Meyer. Near Durban, *Gerrard* and *McKen*, 825; *Wood*, 10167 (2); Hilton, 3,700 feet, *Dimock Brown*, 230 (12); Tintern, 5,000 feet, *Evans*, (2); near Durban, *Wood*, 1207, 10166 (2); without precise locality, *Gerrard*, 319, 825, 1311.

Cyanchum capense Thb. Between Pinetown and Umbilo, *Rehmann*, 8061; near Durban, *Rehmann*, 8797; *Wood*, 611 (7), 4882 (6); without precise locality, *Gueinzius*, *Cooper*, 1282; *Gerrard*, 313, 515.

2. **C. natalitium** Schlechter. Near Durban, *Sanderson*, 547; *Schlechter*, 3082; Wentworth, 1–200 feet, *Sanderson*, 436, partly; Bluff near Durban, 2–300 feet, *Wood*, 5387 (7), 8861 (8).

3. **C. obtusifolium** L. Berea. Durban, *Cooper*, 1265 (?); *McKen*, 7; *Gerrard*, 516; Grant, *Wilms; Wood*, 1662 (5), 3910, 5422 (9); Inanda, 1,800 feet, *Wood;* sea-coast, *Gerrard*, 517; without precise locality, *Gerrard*, 618, 712, 713.

4. **C. sarcostemmatoides** K. Schum. Tugela, *Gerrard*, 1321; "Thorns," Mooi River, 2–3,000 feet, *Wood*, 4339 (4). Also in tropical Africa.

5. **C. schistoglossum** Schlechter. Near Phœnix Station, 120 feet, *Schlechter*, 7090, *Wood*, 7804; near Umhlanga River, 120 feet, *Wood*, 5664 (4); without precise locality, *Gerrard*, 1306.

Sarcostemma viminale R. Br. Near Durban, 2–300 feet, *Wood*, 6416 (5); Umzinyati Falls, 500 feet, *Wood* (5); Mooi River, "Thorns," 2–3,000 feet, *Wood*, 4338 (4); Umkwahumbi, 1,500 feet, *Wood* (in Govt. Herbarium, 1610), (4).

Pergularia extensa N. E. Brown. Near Tugela River, *Gerrard*, 1802. Not seen by us.

Tylophora anomala N. E. Brown. Near Durban, ex Herb. *McKen*, 4; Umgeni, *Gerrard*, 1320. Not known to us.

2. **T. badia** Schlechter, var. **latifolia.** Zululand, *Gerrard*, 2168. Not seen by us. The type is not reported from Natal, but from Cape Colony only.

3. **T. Flanagani** Schlechter. In marshy woods near Durban to 1,000 feet, *Sanderson*, 2006; 'Ngoya, 1–2,000 feet, *Gerrard*, 2169.

4. **T. lycioides** Dcne. Near Tugela River, *Gerrard* and *McKen*, 1800; *Rehmann*, 7166; near Durban, 100 feet, *Wood*, 7517 (3); same locality, *Wood*, 1207; without precise locality, *Sanderson*, 445, 708.

Emplectanthus Gerrardi N. E. Brown. Qudeni, *Gerrard*, 2167. Not known to us.

2. **E. cordatus** N. E. Brown. Tugela, *Gerrard*, 1803; Entumeni, 2,000 feet, *Wylie* (*Wood*, 11397).

Sphærocodon obtusifolium Bth. Near Durban, *Krauss*, 85; without precise locality, *Gerrard*, 1797; Umlazi, *Wood*, 11210.

Marsdenia floribunda N. E. Brown. Coast, *Mrs. Saunders* (*Wood*, 1119); Palmiet, near Durban, 200 feet, *Wood*, 7384 (2); without precise locality, *Gerrard*, 12, 131.

Telosma africana N. E. Brown. Berea, near Durban, *McKen*, 2, 1996; in wood, Berea, near Durban, 150 feet, *Wood*, 3395.

Fockea tugelensis, N. E. Br. Tugela, *Gerrard*, 1310.

Gymnema sylvestre R. Br. Near Umgeni River, *Gerrard*, 1314 (mixed with **Marsdenia floribunda**); damp ravine near Sydenham, *McKen*, 3; Umzinyati Falls, 500 feet, *Wood*, 1249 (3); Palmiet, near Durban, 150 feet (2), *Wood*, 7559. "Also in tropical Africa, Madagascar, and the drier parts of India the Australian plant united with it by Bentham is quite distinct. The fresh leaves of the plant when chewed have the property of destroying the taste of sweetness, as was first observed by Mr. Edgeworth" ("Flora Capensis," vol. iv., p. 783).

Sisyranthus anceps Schlechter. Inanda, 1,800 feet, *Wood*, 265, partly (9), near Gillitt's, 2,000 feet, *Wood*, 6588 (11) (this number is an error, it should be 6586), near Camperdown, 2–3,000 feet, *Schlechter*, 3278.

2. **S. Fanninii** N. E. Brown. Dargle Farm, 3–4,000 feet, *Miss Fannin*, 54. "Allied to **S. virgatus**, but differing in its shorter flowers and open cup-shaped corolla tube" ("Flora Capensis," vol. iv., p. 791).

3. **S. Huttonæ** S. Moore. Shafton, Howick, 3–4,000 feet, *Mrs. Hutton* 407; Greenwich Farm, Reit Vlei, *Fry* in Herb. *Galpin*, 2737.

4. **S. imberbis** Harv. Inanda, 1,800 feet, *Wood*, 376 (12), 1192 (12); Clairmont, near Durban, 20 feet, *Wood*, 3907 (12); without precise locality, *Gueinzius*.

5. **S. Saundersæ** N. E. Brown. Inanda, 1,200 feet, *Wood*, 265 partly (6); without precise locality, *Mrs. Saunders*.

6. **S. trichostomus** K. Schum. Dargle Farm, *Mrs. Fannin*, 51; near Camperdown, 2,500 feet, *Wood*, 5715 (10); Reit Vlei, *Fry* in Herb. *Galpin*, 2736; between Greytown and Newcastle, *Wilms*, 2145; Rock Fountain, *Mrs. Clarke;* without precise locality, *Gerrard*, 2165; *Sanderson*, 136; *Gerrard* and *McKen* in Herb. Natal, 5910.

Tenaris simulans N. E. Brown. Umzumbi, 50–100 feet, *Wood*, 10213 (12).

Riocreuxia picta Schlechter. Ingome Range, *Gerrard*, 1322.

2. **R. polyantha** Schlechter. *Cooper*, 2718, partly. Not known to us.

3. **R. torulosa** Dcne. Near Durban, *Drege; Plant*, 73; *Wood* in Macowan Herb. Austr. Afr., 1732; Inanda, *Wood*, 512; near Nonoti River, *Gerrard*, 643; without precise locality, *Gueinzius*, *Gerrard*, 150. Var. **tomentosa,** Greenwich Farm, Reit Vlei, *Galpin*, 5724; South Downs, 5,000 feet, *Wood*, 4392 (12); Lynedoch, 3–4,000 feet, *Wood*, 4540 (2); Van Reenen, 5–6,000 feet, *Wood*, 4539 (12); common from coast to summit of Drakensberg.

4. **R. Woodii** N. E. Brown. Inanda, 1,800 feet, *Wood*, 338 (12), and in Natal Herb. 181.

Ceropegia ampliata E. Meyer. "Thorns" near Tugela River, *McKen*, 4; *Gerrard*, 1324; without precise locality, *Sanderson*.

2. **C. antennifera** Schlechter. Near Newcastle, 4,100 feet, *Schlechter*, 3426. A very singular plant, of which we have only seen a mutilated specimen.

3. **C. Barklyi** Hook. The type from Transkei. Var. **tugelensis,** N. E. Brown, thorny bush, Tugela River, *Gerrard*, 1323. Not known to us.

4. **C. caffrorum** Schlechter. Near Durban, 150 feet, *Wood* 5376 (2); same locality, *Wood*.

5. **C. carnosa** E. Meyer. Inanda, 1,800 feet, *Wood*, 869 (3); *Haygarth* in Herb. *Wood*, 7535 (4); Zululand, *Wylie* in Herb. *Wood*, 10288 (4).

6. **C. crassifolia** Schlechter. Springvale, *Miss Button* in Herb. *Sanderson*, 2003; Camperdown, *Miss Franks* in Herb. *Wood*, 10703.

7. **C. Haygarthii** Schlechter. Without precise locality, *McKen*, *Sanderson*.

8. **C. linearis** E. Meyer. Near Umzimkulu River, below 100 feet, *Drege*, 4947. Not known to us.

9. **C. Meyeri** Dcne. Umkomaas, *McKen*, 8; Umzinyati Falls, *Wood*, 1307 (5); Oliver's Hoek, 5,000 feet, *Wood*, 3476 (1); without precise locality, *Gerrard*, 430; *Mrs. Saunders*.

10. **C. pachystelma** Schlechter. Umkomaas, 3,000 feet, *Schlechter*, 6705 (2), and Herb. Natal, 7020. The ticket is in Schlechter's writing.

11. **C. Rudatisii** Schlechter. Hill crest, 2,000 feet, *Haygarth* in Herb. *Wood*, 9099 (11); Alexandra County, 2,000 feet, *Rudatis*, 203.

12. **C. Sandersoni** Dcne. Tugela, *Gerrard*, 1798; *McKen* and without precise locality, *Sanderson, Sutherland;* Entumeni, Zululand, under 2,000 feet, *Wood* (4).

13. **C. scabriflora** N. E. Brown. Near Verulam, 3–500 feet, *Wood*, 7908 (11).

14. **C. setifera** Schlechter. The type in Transvaal. Var. **natalensis** N. E. Brown. In thorny bush near Tugela River, *Gerrard*, 1325; Umhloti, 1,200 feet, *Wood*, 1318 (3); near Durban, 3–500 feet, *Wood*, 8261 (1).

15. **C. undulata** N. E. Brown. Tugela, *Gerrard*, 1799. Not known to us.

16. **C. Woodii** Schlechter. Hanging from perpendicular rocks, Groenberg, 2,000 feet, *Wood*, 1317 (2); on the ground in shady bush, Noodsberg, 2–3,000 feet, *Wood*. In a note Mr. Brown says: "There are two forms of this plant. In one the corolla lobes are erect and connivent at the connate tips only; in another form they close together near the base, separating above, with conniving connate tips." Both living plants and dried specimens of these two gatherings have been distributed from the Botanic Gardens at Durban. The habit of the plants in each case is described above. In the Noodsberg gathering the plant formed a large, almost circular clump on the ground, and the stems were short; in the former gathering the plants were solitary and the stems long.

Brachystelma flavidum Schlechter. Alexandra County, Fairfield, 2,200 feet, *Rudatis*, 68. Not seen by us.

2. **B. fœtidum** Schlechter. Zululand, *Thomas*. Not known to us; more plentiful in Kalihari region.

3. **B. Gerrardi** Harv. Emyati, *Gerrard*, 1318; near Krantzkop, *McKen*, 18; Inanda, 1,800 feet, *Wood*, 455, 1607, and in Herb. Natal, 439. In *Wood's* 1607 the corolla on the upper surface was a brilliant metallic green. The late Mrs. Saunders made a coloured drawing of it, which is still in my possession, but the brilliant colour has become very dark with age. The drawing was made in January, 1882. I have collected the plant several times since then, but the colour of the corolla has never been so brilliant.

4. **B. natalense** N. E. Brown. Grassy hill, Inanda, 1,700 feet, *Wood*, 410 (12–1). Not seen in any other locality. The flowers are smaller than in any other species of the genus known to us.

5. **B. pulchellum** Schlechter. Stony ground near Botha's Hill Railway Station, 2,200 feet, *Wood*, 4536 (12); fissures of rocks near Krantzkloof, *Schlechter*, 3178, and without precise locality, *McKen*, 2; *Sanderson*, 342.

6. **B. Sandersoni** N. E. Brown. Tugela, *Gerrard*, 1805; Wentworth, *Sanderson*, 436, partly; Verulam, 3-500 feet, *Wood*, 1161 (11); Clairmont, 20 feet, *Wood*, 3906 (12), and without precise locality, *Gueinzius, Sanderson*, 915.

Anisotoma pedunculata N. E. B. Drakensberg Range, Tiger Cave Valley, 6–7,000 feet, *Evans*, 379; Niginya, 5,500 feet, *Wylie* in Herb. *Wood*, 10529.

Caralluma lutea N. E. B. Near Ladysmith, 3,300 feet, *Wood*. Plants were brought down and flowered in Durban Botanic Gardens.

Huernia hystrix N. E. B. Near Ladysmith, 3,300 feet, *Wood;* near Weenen, 2–3,000 feet, *Haygarth* in Herb. *Wood*, 10813 (4).

2. **H. zebrina** N. E. B. Zululand, *Mrs. Saunders*.

Stapelia nobilis N. E. B. Drakensberg, *Pillans*.

2. **S. gigantea** N. E. B. Indulindi, Zululand, *Wood*. Plants were brought by the writer and planted in the Durban Botanic Gardens, where they still are. Zululand, *Gerrard*, 717, 718.

3. **S. Woodii** N. E. B. Noodsberg, *Wood*, 4119.

ADDITIONS AND CORRECTIONS TO FORMER LIST

MENISPERMACEÆ.

Antizoma angustifolia Miers. Near Weenen, 2–3,000 feet, *Wood*, 10792 (4).

CRUCIFERÆ.

Heliophila Woodii Conrath. Near Durban, 100 feet, *Wood* (10–12). **H. linearis** of former list.

BIXINEÆ.

Dovyalis rhamnoides Burch. Near Durban, *Wood*.

POLYGALEÆ.

Polygala hispida Burch. Bushman's River Valley, 6–8,000 feet, *Wylie* in Herb. *Wood*, 10576 (10).

2. **P. refracta** DC. Tabamhlope, 6,000 feet, *Wylie* in Herb. *Wood*, 10577 (10).

GUTTIFEREÆ.

Garcinia natalensis Schltr. Fairfield, Alexandra County, 2–3,000 feet, *Rudatis*, 150 (11). Not known to us.

TILIACEÆ.

Corchorus discolor N. E. B. Near Stanger, 150 feet, *Wood*, 10186 (12); without precise locality, *Gerrard*, 1130.

GERANIACEÆ.

Monsonia biflora Harv. Indwedwe, 2,000 feet, *Wood*, 948 (7); near Durban, 100 feet, *Wood*, 310 (9).

2. **M. grandifolia** R. Kunth., n. sp. Near Richmond, *Schlechter*, 6731 (2).

3. **M. lanceolata** (Schinz) Kunth. Mount West, 5–6,000 feet, *Schlechter*, 6827; Weenen County, *Wood*, 6724.

Geranium alticola Schltr. Van Reenen, 6–7,000 feet, *Schlechter*, 6994 (2–3).

2. **G. lanuginosum** R. Kunth. Weenen County, 3–4,000 feet, *Wood* (in Govt. Herbarium, 916), (12); Cathkin Peak, 6–7,000 feet, *Thode*.

3. **G. magniflorum** R. Kth. Drakensberg, 7–9,000 feet, *Thode*, 13 (2).

4. **G. Thodei** Schltr. Mont aux Sources, 8–9,000 feet, *Thode* (1).

CELASTRINEÆ.

Gymnosporia Rudatisii Loes. Fairfield, Dumisa, 2–3,000 feet, *Rudatis*, 58 (8).

RHAMNEÆ.

Zizyphus Zeyheriana Sond. On rocks near Ladysmith, 3–4,000 feet, *T. R. Sim* (10).

LEGUMINOSÆ.

Galactia tenuiflora W. and A. Clairmont, 20–40 feet, *Wood*, 10896 (11).

Indigofera alopecurus Schltr. Alexandra County, *Rudatis*.

2. **I. parviflora** Heyne. Weenen County, 2,500–3,000 feet, *Wood*, 10879 (4).

Melolobium microphyllum E. and Z. Var. **decumbens.** Bushman's River Valley, 6–8,000 feet, *Wylie* in Herb. *Wood*, 10656 (10).

Vigna luteola, Bth. Weenen County, *Wood*, 10794.

CRASSULACEÆ.

Crassula hemispherica Thb. Near Ladysmith, *Marloth*. Not known to us.

2. **C. inchangensis** Engler. Inchanga, 2–3,000 feet, *Engler*, 2687 (8).

3. **C. Scheppingiana** Diels. Coldstream, 5–6,000 feet, *Wilms*, 519.

COMBRETACEÆ.

Campylogyne sp. Ngoye, Zululand, 2,000 feet (3), *Wylie* in Herb. *Wood*, 10608.

MELASTOMACEÆ.

Memecylon australe Gilg. and Schlechter. Fairfield, Alexandra County, 2–3,000 feet, *Rudatis* 149 (11).

LYTHRARIEÆ.

Olinia micrantha Don. Drakensberg, *Wood*, 4957 (5). Fruit only.

PASSIFLOREÆ.

Tryphostemma sp. nov. Umlalazi, Zululand, 1–200 feet, *Wood*, 10339 (3).

CUCURBITACEÆ.

Kedrostis glauca Cogn. Near Estcourt, 3–4,000 feet, *Wood*, 10292 (2).

RUBIACEÆ.

Anthospermum sp. Zwaartkop, 4–5,000 feet, *Wylie* in Herb. *Wood*, 10141.

COMPOSITÆ.

Athanasia natalensis Schltr. Fairfield, Alexandra County, 2–3,000 feet, *Rudatis*, 21 (2).

Cineraria geifolia L. Van Reenen, 5–6,000 feet, *Wood*, 10718 (1).

2. **C. montana** Bolus. Drakensberg, 5–6,000 feet, *Wood*, 9925 (2). This was entered in the former list as **C. Haygarthii** Bolus, but was not otherwise published under that name, Dr. Bolus having altered it to **C. montana.**

Helichrysum alticolum Bolus, var. **montana.** Summit of Drakensberg, *Evans*, 742.

2. **H. calocephalum** Schltr. Fairfield, Alexandra County, 2–3,000 feet, *Rudatis*, 137 (10).

3 **H. homolochrysum** S. Moore. Noodsberg, 2–3,000 feet, *Wood*, 933 (4); same locality, 4141 (4).

4. **H. pondoense** Schltr. Fairfield, Alexandra County, 2–3,000 feet, *Rudatis*, 98 (9).

5. **H. setigerum** Bolus, var. **minor.** Van Reenen, 5–6,000 feet, *Wood*, 10771 (1).

Pluchea Dioscorides DC. Lower Tugela, 1–300 feet, *Wood*, 10470.

Senecio cordifolius N. E. B. Bushman's River Valley, 8–10,000 feet, *Wood*, 10663 (10).

CAMPANULACEÆ.

Cyphia longifolia N. E. B. Nottingham Road, 4,800 feet, *Wood*, 4399 (12); Zwaartkop, 4–5,000 feet; *Wood*, 10139 (11).

SALVADORACEÆ.

Azima tetracantha Lam. Without precise locality, *Gerrard*, 1775.

LOGANIACEÆ.

Nuxia dentata R. Br. Near Nonoti River, 3-500 feet, *Wood*, 3578 (5), without precise locality; *Gerrard*, 716 (*N. oppositifolia* of former list.)

Chilianthus corrugatus A. DC. Greenwich Farm at Reit Vlei, *Fry* in Herb. *Galpin*, 2734.

Strychnos dyssophila Bth. Tugela, *Gerrard*, 1660.

GENTIANEÆ.

Chironia Krebsii Griseb. Noodsberg, 2-3,000 feet, *Wood*, 121 (11); *Gillitts*, 1-2,000 feet, *Wood;* near Howick, 3,400 feet, *Wood*, 5007 (11); near Charlestown, 5,500 feet, *Wood*, 4694 (12). (*C. densiflora Scott Elliot* in former list.)

2. **C. rosacea** Gilg. Swampy places, near Durban, *Sanderson*, 39; near Tugela, 500 feet, *Wood*, 3950 (4); Zululand below 1,600 feet, *Wylie* in Herb. *Wood* 5948 (3).

Sebaea acuminata A. W. Hill. Near Boston, 3-4,000 feet, *Wood*.

2. **S. confertiflora** Schinz. Illovo, 2,000 feet, *Wood*, summit of Amajuba, 8,000 feet, *Burtt-Davy*, 7747.

3. **S. imbricata** A. W. Hill. Summit of Amajuba, 8,000 feet, *Burtt-Davy*, 7747*c*.

4. **S. leiostylis** Gilg. 30 to 60 miles from the sea, 2-3,000 feet, *Sutherland;* summit of Amajuba, 8,000 feet, *Burtt-Davy*, 7747*b*; without precise locality, *Gerrard*.

5. **S. longicaulis** Schinz. In a swamp near Karkloof, 3-4,000 feet; similar situations near Byrnetown, *Wood*, 1844 (5). (*S. Woodii Gilg.* in previous list.)

6. **S. macrantha** Gilg. Inanda, 1,800 feet, *Wood* 866 (3), Sevenfontein, 3-4,000 ft., *Wylie* in Herb. *Wood*, 5214 (2).

7. **S. mirabilis** Gilg. Mid Illovo, 1-2,000 feet, *Wood*, 1884 (4).

8. **S. rotundifolia** A. W. Hill. Drakensburg, *Buchanan*. Not known to us.

9. **S. Schinziana** Gilg. Bushman's River, on the Drakensberg Range, *Evans*, 54.

10. **S. Schoenlandii** Schinz. Mount Moreland, 500 feet, *Wood*, 1386 (11).

11. **S. spathulata** Steud. Giant's Castle, 6,000 feet. *Guthrie* in Herb. *Bolus*, 4881.

12. **S. Thomasii** Schinz. Tabamhlope, 6,000 feet, *Wylie* in Herb. *Wood*, 10639 (9); Giant's Castle, *Guthrie* in Herb. *Bolus*, 4882, partly.

13. **S. vitellina** Schinz. Near Cato Ridge, 2,400 feet, *Schlechter*, 3259; near Durban, *Sutherland*, and without precise locality, *Gerrard*.

S. Zeyheri Schinz. In previous list is a Cape species not hitherto found in Natal.

Swertia stellarioides Ficalho. Near Boston, 3–4,000 feet, *Wood*, 10460 (4); near Van Reenen, 7,500 feet, *Schlechter*, 6991.

Limnanthemum thunbergianum Griesb. Near Durban, *McKen*, 757; *Wood*, 83; Inanda, *Wood*, 66; Clairmont, *Sanderson*, 524. (*L. indicum* in previous list.)

BORAGINEÆ.

Lithospermum sp. nov. Zwaartkop, 4–5,000 feet, *Wylie* in Herb. *Wood*, 10136 (11).

SCROPHULARIACEÆ.

Hyobanche sanguinea Thb. Umzumbi, 100 feet, *J. Brickhill* (8).

Moniera cuneifolia Michx. Umlalazi, Zululand, *Wood*, 10382 (3).

LENTIBULARIEÆ.

Utricularia elevata Kam. n. sp. Near Durban, *Rehmann*.

2. **U. Engleri,** Kam. Drakensberg. *Thode*.

ACANTHACEÆ.

Justicia anagalloides T. And. Nondweni, Zululand, *Wood*, 9286 (12).

SELAGINEÆ.

Selago immersa, Rolfe. Giant's Castle, 8-10,000 feet, *Wylie* in Herb. *Wood*, 10665 (10).

VERBENACEÆ.

Lippia scaberrima Sond. Near Weenen, 3,000 feet, *Wood*, 10790 (4).

AMARANTACEÆ.

Celosia triloba E. M. Not known to us.

POLYGONACEÆ.

Oxygonum natalense Schltr. Fairfield, Alexandra County, *Rudatis*, 74 (8).

Rumex Woodii. N.' E. Br. Umhloti, 800 feet, *Wood*, 644. Lambonjwe River, 4–5,000 feet. *Wood*, 3583.

LAURINEÆ.

Cryptocarya sp. nov. Ngoya, Zululand, 1–2,000 feet, *Wylie* in Herb. *Wood*, 10391 (3).

THYMELIACEÆ.

Lasiosiphon triplinervius Dcne. Hoffenthaal, 4–5,000 feet, *Wood*, 3448 (1); Tambamhlope, 6,000 feet, *Wood*, 10557 (10).

EUPHORBIACEÆ.

Euphorbia Cooperi N. E. Br. Not known to us.

MONOCOTYLEDONS.

ORCHIDEÆ.

Habenaria Woodii Schltr. Zululand, 1–2,000 feet, *Wood*, 7601, 9468 (3). (*H. Woodiana* in previous list.)

Huttonæa Woodii Schltr. Near Boston, 3–4,000 feet, *Wood*, 5577 (2).

Satyrium rhodanthum Schltr. Fairfield, Alexandra County, 2–3,000 feet, *Rudatis* 128 (10).

IRIDEÆ.

Gladiolus parvulus Schltr. Fairfield, Alexandra County, 2–3,000 feet, *Rudatis*, 132 (10).

2. **G. subaphyllus** N. E. Br. Zwartkop, 4–5,000 feet (11), *Wylie* in Herb. *Wood*, 10153. Near **G. parvulus** Schltr., but taller with fewer leaves and smaller flowers.

Lapeyrousia grandiflora Baker. Umlalazi, Zululand, 1–200 feet, *Wood*, 10376 (3).

Moræa rivularis Schltr. Fairfield, Alexandra County, 2–3,000 feet, *Rudatis*, 100 (9).

Tritonia flavida Schltr. Alexandra County, 2–3,000 feet, *Rudatis* 91 (9).

AMARYLLIDEÆ.

Crinum Forbesianum Herb. Ginginhlovu, Zululand, 1–200 feet. Flowered in Botanic Gardens, Durban, 1907.

Cyrtanthus Macowani, Baker. Polela, *Mrs. Stone* (*Wood* 11108) (12).

LILIACEÆ.

Albuca oligophylla Schltr. Fairfield, Alexandra County, 2–3,000 feet, *Rudatis*, 99 (9).

2. **A. spiralis** L. Van Reenen, 5–6,000 feet, *Wood*, 10903 (1).

Drimia Rudatisii Schltr. Fairfield, Alexandra County, 2–3,000 feet, *Rudatis*, 79 (8).

Kniphofia porphyrantha Baker. Van Reenen, 5–6,000 feet, *Wood*, 10719 (1).

Ornithogalum ebulbe Schltr. Fairfield, Alexandra County, 2–3,000 feet, *Rudatis*, 136 (10).

Asparagus denudatus, Baker. Camperdown, 2,000 feet. *M. Franks* (*Wood*, 11082).

Gasteria glabra, Haw. in Botanic Gardens, plant from T. R. Sim, Natal.

Aloe ciliaris, Haw. in Botanic Gardens, plant from *Mrs. Okell*, Alfred County.

CYPERACEÆ.

Mariscus binucifer C. B. Clarke. *Schlechter*, 6433, 6664. Not known to us.

GRAMINEÆ.

Agrostis suavis Stapf. Van Reenen, 5–6,000 feet, *Wood*, 8913 (1).

Ischæmum Franksæ. J. M. Wood. Tabamhlope, 6,000 feet, *Wylie* in Herb. *Wood*, 10540 (10).

Panicum stagninum Koen. Near Newcastle, 3–4,000 feet, *W. Sutherland* in Herb. *Wood*, 10007 (3).

INDEX

ON THE RELATIONSHIPS OF THE SOUTH AFRICAN FOSSIL REPTILES TO THOSE OF OTHER PARTS OF THE WORLD.

By R. Broom, M.D., D.Sc., C.M.Z.S.

When Cope first examined the American Permian reptiles he recognised many resemblances between them and the South African forms, and at different times between 1878 and his death he published a considerable number of tentative classifications of the Permian reptiles of America and Africa. In 1878 he proposed the order *Theromorpha* to include as sub-orders the *Pelycosauria* and the *Anomodontia*. Under the *Pelycosauria* he placed not only all the American Permian types but the South African Theriodonts and *Pareiasaurus*, and he believed the whole group to be allied to the *Rhynchocephalia*. As the result of fuller knowledge the types with the temporal region roofed were separated under the name *Cotylosauria*, and the older *Theromorpha*, with the name changed to *Theromora*, was held to include the South African Theriodonts and the American Pelycosaurs proper. Lydekker, Seeley, Zittel, and Gadow all published classifications on similar lines, and all agreed in placing the Pelycosaurs near the African Theriodonts.

In 1897 Baur and Case pointed out that *Dimetrodon* seemed to have a skull with two temporal arches, and that the Pelycosauria should for this and other reasons be separated from the Theriodonts and placed nearer to the Rhynchocephalia. In this most recent writers, including Smith-Woodward, Hay, Zittel, Osborn, McGregor, Boulenger, and Broom have followed the view of Baur and Case.

Notwithstanding the strong evidence that can be adduced for placing the Pelycosaurs near the Rhynchocephalians, there has always been a kind of lingering doubt in the minds of some of us as to whether after all the resemblances between the Pelycosaurs and the African mammal-like reptiles might not represent some genetic relationship rather than merely a parallel similarity.

During my recent visit to Europe I hoped among other things to be able to take a run over to New York to study the Pelycosaurs, but, owing to the press of other work, was on the point of giving up the American trip when I met Professor Osborn in London, and as the result of our

conversation I was persuaded rather to leave some things I was doing and to pay a flying visit to the American Museum. Through the kindness of Professor Osborn and Dr. Matthew I was enabled to examine everything I wished to see, and I had the further advantage of having Dr. Case as a fellow-worker at the Museum. Though Dr. Case was busy working at the Cotylosaurs, and had much new material on hand of both Cotylosaurs and Pelycosaurs, he most generously allowed me to study any of his specimens, and gave me every assistance in his power, including information about the specimens in Chicago. To him, to Professor Osborn, and to Dr. Matthew is largely due the fact that, though I had only a few days in New York, I was enabied to do practically all the work I had hoped to do.

Elsewhere I shall publish the detailed results of my examination of the Pelycosaur and Cotylosaur skulls, and in the present paper confine myself mainly to the conclusions and their bearing on South African problems.

As the result of the researches of Cope, Baur, and Case, and especially of Case, the anatomy of the Pelycosaurs is well known, with the exception of only a few points, and of these latter the most important is the structure of temporal region. By Baur and Case there are believed to be two fenestræ, the upper small and the lower large. According to Case's interpretation the large fenestra is bounded in front by the post-orbital and jugal, and behind by a large triangular bone which he calls the prosquamosal. The small upper fenestra lies between bones which he believes to be post-orbital, the parietal, and the quadrato-jugal. The squamosal he believes to be a narrow bone lying behind the quadrato-jugal. In the skulls in the American Museum I cannot satisfy myself that an upper fenestra exists. The large triangular bone I believe to be the squamosal, and a small bone lying below the squamosal and on the quadrate I believe to be the quadrato-jugal. There is some evidence of a small fenestra between the squamosal and the quadrato-jugal, though in none of the specimens is this region perfectly preserved. There is not improbably a narrow distinct element behind the squamosal, and if it be really distinct it will correspond to the little bone found in the similar region in *Procolophon* and *Captorhinus* (*Pariotichus*), and which has been called epiotic or supra-temporal, but which perhaps might preferably be called post-temporal.

If my interpretation of the temporal region be correct, it follows that the structure in the Pelycosaurs is essentially similar to that in the Therocephalians, differing only in the fact that the latter have lost the quadrato-jugal and the post-temporal bones. Whether there are two fenestræ or only one, it is, I believe, pretty certain that the large opening is the homologue of the temporal fossa of the Therocephalians, and even

if a small opening exists between the parietal, the squamosal, and the post-temporal, the Pelycosaurs might nevertheless be pretty nearly related to the Therocephalians.

Taking into consideration the structure of the skull and other parts of the skeleton, the conclusion to which I come is that the Pelycosaurs and the Therocephalians are groups sprung from a common and not very remote ancestor. The Pelycosaurs retain a number of the more primitive characters, but are in many respects highly specialised. The Therocephalians are more generalised, but considerably more highly evolved. The Pelycosaurs were slow-moving crawlers with short, lizard-like limbs; the Therocephalians were active runners with mammal-like limbs. The difference in the structure of the limb girdles is in harmony with the differences in the limbs.

When we look at other American Permian types we again find curious resemblances to African forms. The order *Cotylosauria* includes a number of types which agree in having the temporal region roofed, but some of those placed in the order are manifestly not very nearly related to the others. *Diadectes*, which is the type of the order, is fortunately well known. It is a large, heavily built animal, with short, feeble limbs. The vertebræ are very like those of the South African *Pareiasaurus*, and though superficially there are striking differences in most other parts of the skeleton, fundamentally there is a surprising similarity. As the Therocephalians differ from the Pelycosaurs in having walking limbs, so *Pareiasaurus* differs from *Diadectes* in having large powerful limbs which could easily keep the body off the ground, and the girdles are modified to suit the new habit. Unfortunately the structure of the skull of *Pareiasaurus* is not well known, but the agreement is sufficient to justify us in concluding that *Pareiasaurus* is related to *Diadectes* in much the same way that the Therocephalians are to the Pelycosaurs.

Another small type that is at present placed in the Cotylosauria is called *Pariotichus*, or, as Dr. Case informs me, it ought to be called *Captorhinus*. This is a small lizard-like Cotylosaur which was of fairly active habit, and has evolved to a considerable degree along the line which gave rise to the Rhynchocephalians. It differs from *Diadectes* and *Pareiasaurus* in having a rounded instead of a flat occipital condyle, and with the exception that the temporal region is roofed and the precoracoid is still retained, there is little, if anything, to distinguish it from the primitive Rhynchocephalians. To us at present its chief interest lies in the fact that it is distinctly related to the South African forms *Saurosternon* and *Procolophon*. The African types are more specialised, but they are probably more nearly related to *Captorhinus* (*Pariotichus*) than are the Therocephalians to the Pelycosaurs.

In the American Permian beds are many Stegocephalians, of which

the best known are *Eryops*, *Trimerorachis*, and *Cricotus*; in South Africa Stegocephalians are rare in the Lower Karroo, but the only known form, *Rhinesuchus*, is probably allied to *Eryops*, and was originally referred to that genus by Lydekker.

While the Lower Karroo fauna cannot have directly sprung from the fauna of the American Permian nor the American forms from Karroo ancestors, it is manifest that the two faunas are related in such a way as to render it practically certain that they are two different modifications of the same earlier fauna. The American types are nearer the ancestral, though considerably specialised; the African, probably owing to their living in the swamps of the Karroo, have developed greater length of limb and tended to become more active. The home of the common ancestral forms was probably in a southern continent which joined Brazil and South Africa. As reptilian remains are extremely rare in beds older than those which contain *Pareiasaurus* and the Therocephalians, though the extensive Ecca beds are of exactly the same sort of shale as is found in the fossiliferous beds above, we are probably justified in concluding that in Lower Permian times reptiles for some reason were very rare in South Africa, and as the ancestral Permian fauna must have been flourishing elsewhere, we may conclude that it probably was mainly confined to the western part of the southern continent. Further, during the greater part of Dwyka times there could have been no land vertebrates in South Africa, as the land was covered with snow and ice, and similar conditions existed in Southern Brazil. Hence the probability seems to be that in Upper Carboniferous times the ancestors of the Permian reptiles flourished in the northern part of what is now South America, and that before the onset of the Permian age representatives of most of the types invaded North America, where they soon became isolated, and after undergoing considerable specialisation became extinct about the middle of the Permian period. The main body of reptiles probably passed south as the climate became more temperate. A few forms probably extended across the continent shortly after the glacial conditions disappeared, as, for example, *Mesosaurus*, and others of a more hardy sort gradually followed. But it was apparently not till near the middle of Permian times that the large body of the Permian types arrived in South Africa.

In South Africa the conditions must have been such as to promote rapid evolution, and many new types soon appeared. The most remarkable are the Anomodonts, which are evidently greatly specialised descendants of some Therocephalian-like type, but *Dicynodon* is not likely to have sprung from any known Therocephalian and may have evolved from a somewhat more primitive type more nearly allied to the Dinocephalians. From the great variety of Anomodonts found in South Africa and from

the great prevalence of certain genera, it seems probable that South Africa is the original home of the Anomodonts.

During the greater part of Permian times the Southern continent was divided from Europe by sea, but towards the end of the Permian a land connection, probably in Asia, allowed the Pareiasaurian fauna to pass into Europe, and with the fauna the advanced Southern types of vegetation. In Russia have been found Pareiasaurians scarcely distinguishable from those of South Africa, Therocephalians perhaps generically identical with African forms, Anomodonts closely allied to, if not identical with, *Dicynodon*, and Stegocephalians. Perhaps the last of the wave of South African emigration is to be seen in the lower Elgin fauna of Scotland with *Elginia*, *Geikia*, and *Gordonia*.

After Permian times there is no evidence of any European connection till we come to the Upper Triassic beds of Burghersdorp, and we find the remarkable state of affairs that while Africa received a large accession of European new types Europe apparently did not succeed in getting any of the African Cynodonts which form such a distinctive feature of the South African Upper Triassic beds. Probably the connection was an indirect one by means of a large island which became first separated off from the northern continent and later on became joined to the southern land. Whatever be the explanation, we know that in Upper Triassic times Labyrinthodonts closely allied to the European appeared in South Africa. The species of *Capitosaurus* and *Cyclotosaurus* are almost identical with those of Europe, and the species of *Trematosaurus*, though larger than the European, is closely allied.

In Lower Jurassic times the land connection with Europe must have been well established, as the Dinosaurs of the Stormberg beds are nearly identical in some instances with European forms. Further, the small mammal *Tritylodon* is very closely allied to *Triglyphus* of Europe.

There is little evidence to show how closely Africa was connected with Australia during Permian and Triassic times, but in Upper Triassic times at least there is some evidence of continuous land having been between the Cape and Australia, but whether it extended through India or the present Indian Ocean there is little evidence. The occurrence of small land reptiles in the Karroo beds of Madagascar seems to suggest that much of the Indian Ocean may in the Permian age have been land.

After Lower Jurassic times too little is known of the land faunas of South Africa to afford us evidence of the relations of Africa to the other continents. In fact, almost nothing is known of the land fauna till we arrive at Pleistocene times. A lower cretaceous Sauropodous Dinosaur is known and the frontal bone of a small cretaceous crocodile, probably a Teleosaur, has been discovered.

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EUROPE.

AMSTERDAM.

Koninlijke Akademie van Wetensschappen te Amsterdam.
(Proceedings of Meetings, Proceedings of Sciences.)

BASEL.

Verhandlungen der Naturfoschenden Gesellschaft.

BERLIN.

Deutsche Entomologische Zeitschrift.
Sitzungberichte der Kon. Preuss. Akademie der Wissenschaften.

BERN.

Der Schweiz Naturf. Gesellschaft.

BOLOGNA.

Mem. della R. Accademia delle Scienze.

BRUSSELS.

Académie Royale de Belgique.
(Bull. de la Classe des Sciences ; Annuaire).

CAMBRIDGE.

Report of the Library Syndicate, Cambridge University Library.
Transactions and Proceedings of the Cambridge Philosophical Society.

CASSEL.

Abhandlungen und Bericht des Vereins für Naturkunde.

DRESDEN.

Mitteilungen des Vereins für Erdkunde.

EDINBURGH.

The Scottish Geographical Magazine.
Proceedings of the Royal Physical Society.
Proceedings of the Royal Society of Edinburgh.
Proceedings of the Scottish Microscopical Society.
Transactions of the Royal Society of Edinburgh.

GENOVA.

Annali del Museo Civico di Storia Naturale.

GLASGOW.

Proceedings of the Royal Philosophical Society.

GOTTINGEN.

Nachrichten von der Koniglichen Gesellschaft. der Wissenschaften zu Göttingen (Mathematische-Physicalische Class Geselschaftliche Mittheilungen).

HALLE.

Leopoldina amtliches Organ der Kaiserlichen Leopoldino-Carolinischen Deutschen Akademie der Naturforscher.
Nova Acta der Ksl. Leop.-Carol. Deutschen Akademie der Naturforscher.

HAMBURG.

Jahrbuch der Hamburgischen Wissenschafte Anstalten.
Jahrgang der Hamburgischen Wissenschafte Anstalten.

LAUSANNE.

Bull. de la Société Vaudoise.

LEIPZIG.

Ges. d. Deutsch. Naturf. und Aerzte.
Konig. Sechenb. Gesels. d. Wissenschaften.
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LEYDEN.

Association Internationale des Botanistes.

LISBON.

Boletin da Sociedade de Geographia de Lisboa.

LIVERPOOL.

Proceedings of the Geological Society.

LONDON.

International Catalogue of Scientific Literature.
Proceedings of the London Royal Society.
Reports of the Evolution Committee.
Proceedings of the London Zoological Society.
Transactions of the London Zoological Society.
Minutes and Proceedings of the Institute of Civil Engineers.
Proceedings of the Royal Colonial Institute.
Quarterly Journal of the Geological Society.
Quarterly Journal of the Meteorological Society.
Report of the British Association for the Advancement of Science.

LONDON (*continued*).

Royal Astronomical Society (Monthly Notices, Memoirs).
The Geographical Journal.
Journal of the Anthropological Institute.
Catalogues of the British Museum, Natural History.
Royal Botanic Garden, Kew. Bulletin of Miscellaneous Information.
Board of Education Reports.
Flora Capensis.

LUZERN.

Verhandlungen der Schweizerischen Naturforschenden. Gesellschaft.

MANCHESTER.

Journal of the Manchester Geographical Society.
Memoirs and Proceedings of the Manchester Literary and Philosophical Society.

MARSEILLES.

Annales de la Faculté des Sciences.

MOSCOW.

Bulletin de la Société Impériale des Naturalistes.
Nouveaux Mémoires de la Société d'Histoire Naturelle de l'Ouest de la France.

NAPOLI.

Rendiconti dell Accademia delle Scienze Fisiche e Matematiche.
Atti dell' Accademia delle Scienze Fisiche e Matematiche.
Annuario del Museo Zoologico.
Bollettino del Laboratorio di Zoologia e Agraria.

PARIS.

La Feuille des Jeunes Naturalistes.
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PORTICO.

Bollettino die Laboratorio di Zoologia Generale e Agraria.

ROME.

Atti della Reale Accademia dei Lincei.
Rendiconti della Reale Accademia dei Lincei.
Atti della Societa Italiana per il Progresso delle Scienze.

ROTTERDAM.

Tijdschrift voor Entomologie.

SASSARI.
Studi Sassaresi.

STOCKHOLM.
Konig. Svenska Vetenskaps Akademie (Handlingar; Arkiv. för Botanic, Zoolog., Kemi. et Mch., Matematic).
Antivarisk Tijdskrift för Sverige.
Meddelanden Nobel Instit.
Les Prix Nobel.

ST. PETERSBURG.
Mémoires and Bulletin de l'Académie Impériale des Sciences.

TORINO.
Atti della Reale Accademia delle Scienze.
Bolletino dei Musei di Zoologia ed Anatomia comparata della Universita di Torino.
Osservazioni Meteorlogiche.

UPSALA.
Results of the Swedish Zoological Expedition.
Bulletin of the Geographical Institution of the University of Upsala.

VIENNA.
Annalen des K.K. Natur. Historichen Hofmuseums.
K.K. Akademie der Wissenschaften (Denkschriften, Mitteilungen).

ZURICH.
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AUSTRALIA.

ADELAIDE.
Meteorological Observations made at the Adelaide Observatory.
Proceedings of the Royal Geographical Society of Australasia.
Memoirs, Transactions, and Proceedings of the Royal Society of South Australia.

BRISBANE.
Annals of the Queensland Museum.

MELBOURNE.
Proceedings of the Royal Society of Victoria.
Memoirs of the National Museum.

SYDNEY.

Records, Memoirs, and Report of the Australian Museum.
Records of the Geological Survey of N.S.W.
Transactions of the Royal Society.
Publications of the Observatory.
Journal of the Royal Anthropological Society of Australasia.

WELLINGTON.

Transactions of the New Zealand Institute.

NORTH AMERICA.

AUSTIN.

Transactions of the Texas Academy of Sciences.

BALTIMORE.

Johns Hopkins University Studies, University Circular, Hospital Bulletin.

BERKELEY.

Publications of the University of California.
(Botany, Pathology, Geology, Zoology, Physiology, American Archæology and Ethnology, Bulletin.)
Report of the Agricultural Experimental Station.

BOULDER.

Publications of the University of Colorado Studies.
Colorado College Studies.
(Science Series, Language Series.)

BROOKLYN.

Cold Spring Harbor Monographs.

CAMBRIDGE.

Bulletin of the Museum of Comparative Anatomy.

CHICAGO.

Field Columbian Museum.
(Publications, Zoological Series, Geological Series, Botanical Series, Report Series.)

CINCINNATI.

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Bulletin of the Lloyd Library; Mycological Notes.

DAVENPORT.

Proceedings of the Davenport Academy of Sciences.

HALIFAX.

Proceedings and Transactions of the Nova Scotian Institute of Science.

Hamilton.
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Minneapolis.
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Missoula.
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WASHINGTON.

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SOUTH AMERICA.

BUENOS AYRES.

Anales del Museo Nacional de Buenos Aires.

CORDOBA.

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LA PLATA.

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LIMA.

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MONTEVIDEO.

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RIO DE JANEIRO.

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SANTIAGO.

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ASIA.

BATAVIA.

Mededeilingen intgaande van het Department van Landbouw.

CALCUTTA.

Journal and Proceedings of the Asiatic Society of Bengal.

MANILA.

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AFRICA.

BULAWAYO.

Rhodesian Museum Annual Report.
Proceedings and Report of the Rhodesian Scientific Association.

Cape Town.

Report of the Government Biologist.
Marine Investigations in South Africa.
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CORRIGENDA.

P. 288, line 27, *instead of* Nemognatha capensis, sp. n., *read* Nemognatha peringueyi, Fairm., Bull. Soc. Entom., France, 1883, p. lxx.

P. 241, line 27, *instead of* Actenodia discrepans, n. sp., *read* A. schultzei, Pic., Denksch. Med. Naturwis. Ges. Jena, vol. 13, p. 141.